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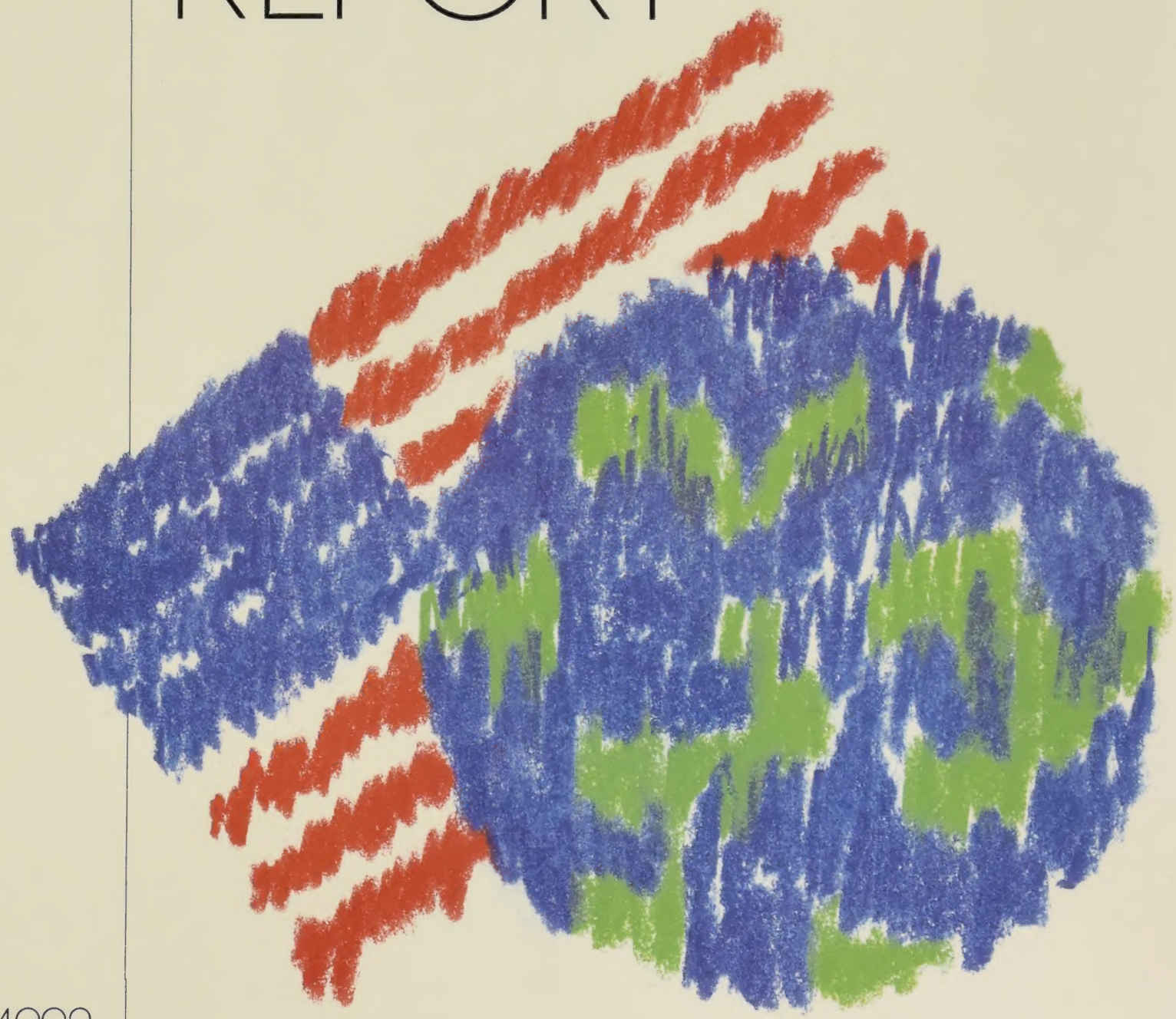
UNITED STATES OF AMERICA NATIONAL REPORT



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ENVIRONMENT & DEVELOPMENT

United States of America National Report

1992

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EXECUTIVE SUMMARY
United States National Report

Overview

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U.S. Population and the Environment

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Human Health and the Environment

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Indigenous Peoples

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Economics, Energy and Agriculture

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Environmental Law and Institutions

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Natural Resources Endowment and Key Environmental Issues

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Environmental Emergencies

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Environmental Impact Assessment

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Environmental Education

The United States has produced this report as part of the preparations for the United Nations Conference on Environment and Development (UNCED) to be held in Brazil in June 1992. In accordance with guidance provided by the Preparatory Committee for UNCED, this report presents the national perspectives and experience of the United States, "together with information on policies, activities and issues at the national level." It summarizes this nation's efforts to protect and enhance the quality of the human environment in concert with its efforts to provide economic well-being during the two decades since the United Nations Conference on the Human Environment was held in Stockholm.

The information presented in this report is primarily and deliberately retrospective. It is an attempt to portray the many human, economic and natural resources of the United States, to describe resource use and the principal national laws and programs established to protect these resources, and to analyze key issues on the agenda of UNCED. This analysis is presented in terms of past and present conditions and trends, measures of progress made in responding to the key issues, and a summary of government activities, underway or pending, to address ongoing or newly emerging national environmental and resource management problems.

OVERVIEW

Although most of this report's information and analysis is presented in the following chapters, each of which addresses specific resources and programs, four recurring themes contain some lessons learned from the past and suggest some strategies needed for the future:

The roles of economic development and environmental protection are inseparable. Economic growth and even more rapid growth in environmental investments occurred during the last 20 years in the United States. It became clear that support for investments in environmental protection increased with sustained economic growth, and that environmental well-being is an important component of that growth. U.S. gross national product (GNP) grew 59 percent from 1972 to 1990, while emissions of lead to the air and emissions of industrial suspended solids to the water fell by 96 percent over that same time period.[1] Moreover, economic growth occurred along a new path that included significantly larger investments in cleaner air, land and water. Energy efficiency improved, resulting in associated environmental improvements. As the end of the two-decade period approaches, increasing attention is being devoted to integrating economic and environmental concerns, improving approaches to valuing natural resources in economic decision-making, and developing mechanisms for harnessing economic incentives to achieve environmental goals.

Much has been accomplished. The United States has made impressive strides in protecting the health of its citizens and restoring the quality of the nation's environment since the early 1970s, when a series of national programs and government agencies were created in response to public demands to correct widespread pollution and degradation in resource quality, especially of the air and water.

New public health programs identified environmental health hazards and pathways of exposure, and developed improved detection methods and strategies to reduce health risks from environmental contaminants.

Federal air and water pollution programs were created, with nationwide standards and permit and enforcement procedures. These

programs have in general been successful in controlling discharges of pollutants to air and water from the sources the programs were empowered to control. These controls have produced large, measurable improvements in air quality, as well as notable improvements in the quality of surface waters that were polluted primarily by sewage and industrial point-source discharges. Some very harmful pesticides and other toxic chemicals have been removed from U.S. production, and the level of their residues in the environment are decreasing. Solid and hazardous wastes are being handled more safely. The U.S. population and economy have grown over the past two decades, and the population is much healthier than it would have been without environmental protection programs. The environmental protection programs cost U.S. citizens and corporations roughly $115 thousand-million annually (in private- and public-sector pollution control costs only), or about 2.1 percent of the U.S. gross national product.[2]

Management of the nation's natural resources has also improved. While the amount of agricultural and forestlands in production has not expanded, improvements in efficiency have led to marked increases in food and timber production. Fish populations are returning to waters that had previously been badly polluted, overfished or both. In large part because of greatly enhanced public involvement in federal environmental decision-making, more environmentally sensitive management strategies are being carried out by the federal agencies responsible for most of the nation's water resources and nearly one-third of the nation's land area.

In the industrial sector, a major change is occurring in engineering design and quality control; more efficient use of energy and raw materials, waste minimization and pollution prevention are increasingly viewed as part of total quality management, rather than as burdens imposed by regulation. Market-based incentives are emerging as tools to supplement, and potentially to supplant, some types of rigid command-and-control regulations. Already, market-based incentives have been used to implement the phaseout of lead in gasoline—long before other nations removed lead from their auto fuels. And market incentives are being used to cut U.S. sulfur dioxide emissions in half and to phase out chlorofluorocarbons (CFCs). As of June 1991, production of CFCs and other chemicals that deplete the stratospheric ozone layer was being phased out 42 percent faster than required by the Montreal Protocol. Uses of these stratospheric ozone-depleting chemicals are being rapidly phased out on a voluntary basis in advance of regulatory requirements. Additionally, the total amount of hazardous waste generated annually in the United States is declining.

Individuals have also become much more aware of the adverse health and environmental risks of excessive resource consumption; citizen groups and local governments have instituted recycling programs and other conservation measures. Through selective purchasing, Americans have begun to use the marketplace to achieve reductions in wasteful product packaging and greater energy efficiency in automobiles, appliances, and home heating and cooling systems.

Private as well as government-sponsored research programs have developed improved methods for monitoring environmental conditions and identifying potential hazards. Universities and other scientific research institutions are developing and refining methods to more accurately assess risks to public health and the environment from a wide range of sources. These efforts are making possible more objective and efficient strategies for prioritizing and reducing those risks.

Public participation in decision-making and enforcement has been a key aspect of the accomplishments of the United States in environmental protection. The public has had increasing access to information, reinforcing

the concept that it has a "right-to-know." The public has also had tremendous influence through its participation in public reviews of environmental impact assessments, for comments on proposed regulations and citizen enforcement of environmental laws.

Much remains to be done. As with many complex, long-term enterprises, resolving many of the first-order environmental problems that were prominent in the 1970s revealed a set of second-order problems, the resolution of which will require persistence and the use of different tools and different strategies.

Some of the goals set in the 1970s for control of air and water pollutants have not yet been met; in addition, new problems have emerged that are likely to be more technically difficult and more costly to solve. Of the regulated or "criteria" air pollutants, the reduction of ozone levels in the lower atmosphere has proven particularly difficult. Health risks from elevated ozone levels in populated regions and ozone damage to crops and natural systems are continuing problems. A substantial number of counties in the United States still fail to meet national air quality standards for ozone or other regulated air pollutants during some part of the year. Furthermore, in the process of controlling conventional air pollutants, other significant pollution problems came to light. Nearly 200 toxic air pollutants not initially subject to regulation under the Clean Air Act were identified; these substances may present risks to human health, particularly in closed indoor workplaces or dwellings. Recent amendments to the Clean Air Act require significant reductions in industrial emissions of these chemicals.

Trends in the nation's water quality are difficult to measure. Although adequate wastewater treatment is now provided for more than three-quarters of the U.S. population, one-third of the nation's assessed river kilometers recently failed to fully meet state water quality standards. The combination of poorly treated sewage plus nutrients, sediment and toxic chemicals in agricultural and urban runoff requires more attention. Deposition from air to water of nutrients, toxic substances and acidic agents appears to be causing water quality problems in some estuaries and lakes, including the Chesapeake Bay and the Great Lakes.

Habitat alteration and destruction, including continuing losses of old-growth forests and wetlands, are growing concerns. Continuing loss of natural communities is the principal cause of declining biological diversity. Notable declines in waterfowl populations during the past 20 years are attributed to loss of wetlands; major reductions in commercial fish populations appear to be caused by a combination of overfishing, habitat alterations, coastal water pollution and competition from non-native fish species. Management of habitat to protect species listed as endangered or threatened poses particularly difficult conflicts between economic and environmental uses of the nation's land, water and biological resources.

A new international environmental problem emerged in the mid-1970s following discovery of stratospheric ozone depletion and the role played by industrially produced chlorofluorocarbons (CFCs) in accelerating the destruction of stratospheric ozone. The phenomenon of global warming, and the debate over the extent to which anthropogenic greenhouse gases are enhancing that warming—potentially leading to global climate change—became another major international environmental issue. International agreements were negotiated to phase out CFC production; a lively debate continues about what steps are necessary and appropriate to reduce net greenhouse gas emissions.

In the past 20 years, the United States has made progress in slowing the rate of increase of energy and resource consumption. There is a growing awareness of the need to make further efforts to conserve energy and to

promote a more energy-efficient economy. In the energy sector, increasingly private industry is engaging in partnerships with state and federal governments to develop energy-efficient technologies in the residential, commercial and industrial sectors. Reducing energy demand also reduces capital investment requirements and associated pollution effects.

New environmental management strategies are needed. The challenge for the United States is to strengthen those institutional frameworks and strategies which promote a sustainable society, in which environmental and economic objectives are mutually supporting. The challenge of the concept of sustainability can only be met by the engaged leadership of *all* sectors of society. The United States has the capability to manage its growth and development; complex challenges require the rigorous application of innovative strategies and tools. Trends in the nation's environmental management strategies clearly demonstrate an ability to develop and implement new concepts. Among them are risk-based environmental planning and regulations, market-based incentives for pollution reduction, pollution prevention programs and environmental education programs.

Risk-based environmental planning and regulation incorporate the use of the available scientific information to best use limited resources to reduce risk to human health as well as local and global ecosystems. Reducing risk involves setting priorities and developing integrated strategies for environmental management. A sound science and information base is essential to identify these priorities and to allocate resources based on risks.

Further progress in reducing environmental risks requires an enhanced knowledge base concerning the health and environmental risks of pollutants, the means to reduce the generation of pollutants, technologies to control emissions and the longer term impact of pollutants from all sources of the globe. To build such a comprehensive science and information base, the United States is accelerating its research into trends in ecological systems, the population's exposure to environmental pollutants, life cycle analysis and national environmental accounting systems, the role of social forces in environmental protection, and long-term environmental problems and forecasting techniques.

Recent U.S. applications of market-oriented environmental policies include the use of tradable credits for lead in the phaseout of leaded gasoline; the use of taxes to encourage the phaseout of chlorofluorocarbons; and the use of tradable allowances for industrial emissions of sulfur dioxide (allowed by a provision in the Clean Air Act Amendments of 1990). The emissions trading program of the Clean Air Act Amendments is expected to achieve the same environmental quality goal as alternative regulatory approaches, but with a cost saving of approximately $1 thousand-million per year.

Pollution prevention approaches, key to reducing risk, have been employed increasingly, often through a cooperative partnership between government and industry. Companies can prevent pollution in several ways, including better management of resources, changes in production techniques and materials substitutions. Prevention reduces wastes, associated costs and potential liability; as a result, pollution prevention practices can enhance economic competitiveness.

Environmental education is a key to effectively implementing new approaches. To help develop a more scientifically literate and environmental knowledgeable citizenry, the United States has developed ambitious national education goals. Also, Congress and the executive branch have acted to strengthen environmental education programs. Decision-makers and the general public need ready access to information about the environment and

relative risks to make informed choices. Education is inextricably linked with prevention.

The report contains a wide array of detailed information, ranging from statistics to case studies. Following are highlights of each chapter in the National Report:

U.S. POPULATION AND THE ENVIRONMENT

Chapter 1 profiles the growth and composition of the U.S. people and the environmental impacts of these demographic trends. The United States population of 250 million in 1990 ranked fourth among all countries, after China, India and the former Soviet Union. The natural rate of increase (the excess of births over deaths) has held steady at about seven per 1,000 population annually over the past 20 years, equivalent to a 0.7 percent growth rate. In recent years, net immigration has accounted for an increasing proportion of population growth—approximately 29 percent. The average life expectancy at birth in 1990 was 75.4 years of age.

The U.S. population has become far more metropolitan. This metropolitan growth has been concentrated in the "Sun Belt," the southern tier of states across the country. About 110 million people live in coastal areas, with the most densely populated coastal zone in the Northeast accounting for more than one-third of the nation's coastal population.

The participation of the working-age population (16-years-old and over) in the paid labor force rose consistently, representing 66.4 percent of the civilian population in 1990; the overall participation rate for women is expected to continue to rise. Real median household income in 1989—$28,900—was 6.7 percent higher than the 1972 median (adjusted for inflation). The official poverty rate was 11.9 percent in 1972 and 12.8 percent in 1989. Environmental quality in the United States, as elsewhere, is influenced by population growth. People use natural resources and generate wastes in the course of producing and consuming goods and services. By effectively integrating environmental considerations into development planning and project reviews, many types of pollution were greatly reduced while the U.S. population grew about 22 percent from 1970 to 1990.

HUMAN HEALTH AND THE ENVIRONMENT

Chapter 2 highlights the links between human health and the environment. Federal, state and local efforts to ensure safe supplies of food and water, to manage sewage and municipal wastes, and to control or eliminate communicable illnesses have contributed substantially to human health improvements in the United States. The past 20 years mark a great expansion of knowledge about environmental threats to human health. Since 1970, the United States has established several different agencies that address different aspects of environmental health issues. Major advances have also been made in the use of scientific methods to assess the significance of those threats. The most difficult challenges for environmental health today come from uncertainties about the human health effects of naturally occurring substances such as radon, society's pervasive use of fossil fuels and synthetic organic chemicals, and the presence of their combustion or breakdown products in our air, water, food, workplaces and homes.

Occupational safety and health is a major concern, with continuing efforts to reduce the effects of exposure to a number of hazardous substances,

including lead, formaldehyde, dust, dyes and cleaning fluids. As a greater number of women of child-bearing age have been entering the work force, special research has focused on the reproductive effects of repeated exposure to such substances.

INDIGENOUS PEOPLES

The indigenous population of the United States represents a multitude of distinct cultures and ethnic groups. Chapter 3 discusses the relationship of the federal government to Native Americans in the continental United States, Alaska Natives and the indigenous peoples in the U.S. insular areas (areas that are not states or parts of states but are under the sovereignty of the United States). Issues confronting all three of these groups include the struggle to preserve the environment while seeking to achieve economic growth.

Developments over the past 20 years among the indigenous peoples of the United States and the insular areas reflect an acceleration of economic, social, cultural and environmental changes that began shortly before World War II. The access of a majority of indigenous populations in the United States and the insular areas to industrial technology during the war set the stage for development of their lands, rivers and other natural resources after the war was over. Population growth has increased the demand for economic development, often in the form of oil, gas and coal extraction, and agricultural diversification.

To help ensure that economic development and environmental protection advance together, the United States is assisting indigenous peoples in the areas of environmental monitoring, resource conservation, waste treatment and disposal, environmental education and environmental infrastructure development. A major step toward the achievement of these goals is the development of cross-boundary cooperation. Each indigenous population, no matter how vast or limited its environmental regulatory jurisdiction, can develop cooperative relationships with neighboring federal, state and local jurisdictions to seek solutions to shared complex problems.

ECONOMICS, ENERGY AND AGRICULTURE

Chapter 4 provides facts on economic growth and conservation, together with information on international trade, international assistance programs, technology transfer, and the costs and benefits of environmental improvement. It also features sections on energy and agriculture—key links in understanding the relationship between the environment and development.

Economic Development and the Environment

The price of improving the environment (in private and public sector pollution control costs only) is estimated to be $115 thousand-million in 1990 and projected to be between $171 and $185 thousand-million in the year 2000, representing more than 2.5 percent of projected gross national product (GNP) in the latter year. These substantial expenditures reflect a strong national commitment to environmental quality. The benefits of environmental improvement are difficult to quantify consistently in economic terms because damages caused by pollution are not fully reflected in the market economy. Data on the decline in various emissions, either compared to earlier years or relative to what the emissions would have been without emission controls, provide evidence of benefits from environmental programs.

During the last 20 years, the United States has enacted a number of domestic laws and ratified several international agreements to help achieve environmental objectives. The interaction of international trade and the environment is receiving increasing attention, both from the federal government and from U.S. industries and citizens' organizations, who are addressing such issues as competitiveness, relocation of industries to jurisdictions with less strict environmental controls and the export or import of goods that do not meet U.S. environmental standards.

Development assistance is also a component of the international economic system; the United States has provided approximately $155 thousand-million in international economic assistance since 1972, with numerous programs devoted to both economic development and the environment. Technological cooperation is facilitated by direct foreign investment by U.S. manufacturing corporations, which represents over a third of their assets, and the scientific education of foreign students in the United States, who represent almost a quarter of the doctoral degrees granted in science and engineering.

Energy and Environmental Quality

The United States is both a major consumer and producer of energy. It possesses vast energy resources that are, for the most part, produced, distributed and transported by the private sector. The past 20 years have seen an evolution in the way the United States seeks to balance energy supply and use with environmental concerns, shifting the approach from tight regulatory control toward market incentives.

Total energy consumption increased only 14 percent between 1972 and 1990, although GNP increased 58 percent; energy consumption per dollar of GNP has declined consistently since 1972. Industrial consumption remained relatively unchanged, but energy embodied in imported manufactured goods increased dramatically. Consumption in the commercial sector increased nearly 40 percent, while transportation consumption increased 25 percent, and residential consumption increased about 13 percent. Energy efficiency increased significantly in every economic sector.

It has been the experience of the United States over the past 20 years that in order to maintain a viable economy, energy production and use must be balanced with concerns for a sustainable environment. A recently adopted National Energy Strategy is designed to spur more efficiency and competition throughout the energy sector, expand fuel and technology choices, improve research and development, and support international efforts in energy, economic security and environmental policy.

Agriculture in the U.S. Environment

The United States enjoys a natural heritage of productive lands and a favorable climate for producing food, feed grains and many other agricultural commodities. The amount of land used for crops has remained relatively stable for several decades because crop productivity per hectare has increased faster than domestic consumption and exports. U.S. agricultural productivity has been aided greatly by a technological revolution that is also helping to increase crop yields throughout the globe. In the absence of technological change, greater amounts of productive land in the United States would be needed to produce current quantities of crops and food, reducing the amount available for conservation purposes, including preservation of forests, wilderness, wildlife refuges and park areas. At the same time several environmental concerns have been associated with traditional agricultural land use, including pollution from animal wastes, runoff from pesticides and fertilizers, and conversion of wetlands for agricultural use.

A variety of successful federally funded conservation programs, dating from the 1930s to the present, are available to farmers. These programs have

made progress in controlling soil erosion, preserving and restoring wetlands, and educating farmers about alternative agricultural practices such as low-input sustainable agriculture. Over the last four years, 1,600 farmers have participated in federal programs demonstrating that farmers can increase their net profit per hectare while reducing soil erosion, ground and surface water contamination, and air pollution from chemicals and equipment usage. Having made significant progress controlling point sources of pollution, the nation has begun to use programs like these to better address the challenges of "non-point" sources of pollution, including agricultural sources.

ENVIRONMENTAL LAW AND INSTITUTIONS

Chapter 5 traces the constitutional sources of authority for modern environmental laws and institutions in the United States, and describes their evolution. In the U.S. federal system, the overarching framework for environmental regulation is the national Constitution. The Constitution generates and demarcates the powers of the three branches of the federal government—the legislature (Congress), the executive branch (the President and the federal agencies), and the judiciary (the federal courts). It also provides the basis for the allocation of statutory authority between the federal and state governments. The "separation of power" among the federal branches, and the relationship between the federal government and the states provide the foundation on which federal and state governments enact, implement and enforce environmental protection laws.

The United States has had a long history of conservation, beginning as early as the late 1800s, when Yosemite and Yellowstone National Parks were set aside as special areas. In the late 1960s and 1970s, rapid growth in environmental consciousness ushered in new laws and institutions. These laws require broad examination of environmental risks and compliance with resource-specific environmental goals, including air and water quality, preservation of endangered species, and control of hazardous wastes and toxic substances. Legal provisions were developed to encourage active public participation in decision-making and enforcement.

New institutions, including the Council on Environmental Quality (CEQ), the Environmental Protection Agency (EPA), and the National Oceanic and Atmospheric Administration (NOAA), were established. Current development of U.S. environmental law is characterized by tough and comprehensive approaches to environmental policy and enforcement, and by regulation that taps the force of market incentives in the service of environmental protection, all in a setting increasingly concerned with the international ramifications of environmental problems and protection measures.

NATURAL RESOURCES ENDOWMENT AND KEY ENVIRONMENTAL ISSUES

Chapter 6 discusses the natural resources profile of the United States, identifies problems and describes approaches to conserve resources and control and prevent pollution. The environmental resources of the United States are vast and varied. Its soils, water resources and range in topography support diverse plant and animal communities. With 60 percent of the land area in the 48 contiguous states under private ownership, the private sector has played a key role in managing the United States' natural resources.

Recently, many private companies, non-profit organizations and individual citizens have responded to the nation's environmental concerns by taking an active role in activities and projects to promote wise stewardship of U.S. natural resources. Federal, state and local governments have also made major contributions in protecting environmental quality through regulation, incentives and education.

Federal environmental protection programs have in general been successful in what they set out to accomplish. While both population and the economy have grown over the past two decades, the U.S. environment is very much cleaner than it would have been without protection efforts. While preserving past gains will require vigorous enforcement of existing regulatory requirements, additional progress is most likely to come through new approaches, including pollution prevention, attention to non-point sources, market incentives, and integrated risk-based planning and management.

Some of the highlights for each section are:

Air Quality

Air quality has improved dramatically in the United States since the 1970s. Emissions of all regulated pollutants except nitrogen oxides have decreased. However, there are areas that are in violation of the federal standards for the most prevalent pollutants. Annual expenditures to control air pollution have increased steadily since 1970. Total costs increased from almost $8 thousand-million in 1972 to an estimated $27 thousand-million in 1987 (in 1986 dollars). Total annual air quality costs in the year 2000 will approach $50 thousand-million, in part due to new Clean Air Act Amendments.

Major air quality issues in the United States include reduction of health risks and ecological damage from remaining air pollutants (especially ozone and toxic chemicals), regional air pollution, transboundary air pollution, and radon and other indoor air pollutants.

Climate Change and Stratospheric Ozone Depletion

Two issues identified as potentially high risks to the natural ecology and human welfare are global climate change and stratospheric ozone depletion. Emissions of carbon dioxide, methane and other greenhouse gases are altering the chemistry of the atmosphere, threatening to change the global climate. Releases of CFCs and other ozone-depleting gases are thinning the Earth's stratospheric ozone layer, allowing more ultraviolet radiation to reach the Earth's surface, thus stressing many kinds of organisms.

The United States accounts for a significant portion of global net emissions of greenhouse gases. However, while the GNP increased nearly 50 percent between 1973 and 1988, carbon dioxide emissions in the same period increased by only 2.7 percent. In the face of scientific uncertainty concerning global climate change from a rise in atmospheric concentrations of greenhouse gases, the United States supports continued scientific research to reduce those uncertainties, and actions which reduce potential climate change in addition to serving other economic or environmental goals. The federal government is investing over a thousand-million dollars annually in global climate change research. In addition, the United States is taking several steps that could have a beneficial effect in mitigating future climate change—but are justified for a variety of reasons, such as reducing air pollution and increasing energy efficiency.

In 1978, the United States banned the use of chlorofluorocarbons (CFCs) in non-essential aerosol propellants. In 1987, the United States signed the Montreal Protocol which committed the country to reduce other uses of CFCs 20 percent by mid-1994 and 50 percent by mid-1999. In 1990, in response to evidence of accelerated damage to the ozone layer, the Montreal Protocol was amended to call for a full phaseout of CFCs and most other ozone-depleting chemicals by 2000. The new Clean Air Act goes beyond the

Montreal Protocol in its restrictions on ozone-depleting substances, and in early 1992, the United States announced that it would accelerate its phaseout schedule by ending production of CFCs and most other ozone-depleting substances by the end of 1995.

Freshwater and Wetlands

The present condition and trends of America's water quality reflect some significant improvements over the past 20 years. Numerous steps have been taken to make America's waters fishable and swimmable and to improve and ensure the quality of drinking water. Nevertheless, widespread non-point sources of pollution, responsible for about half of the impairment to the nation's rivers, streams and lakes, remain a challenge. Toxics from point and non-point sources continue to present long-term threats to aquatic habitats and wildlife in many areas, including coastal areas, the Great Lakes and wetlands.

Population pressures are increasing the sources of pollution and, at the same time, are leading to increased demand for clean water. Some regions experience chronic shortages, and several steps have been taken toward conservation and more efficient use of existing supplies of both surface and groundwater. Diseases from contaminated water, such as cholera and typhoid, have essentially been eliminated; toxic chemicals and microbiological contaminants remain a threat to surface and groundwater sources. The number of people served by sewage treatment plants having "secondary" treatment or better increased 69 percent between 1972 and 1988.

Wetlands provide essential breeding, spawning, nursery, nesting, migratory and/or wintering habitat for a major portion of the nation's fish and wildlife. Hydrologic functions include surface and groundwater recharge and discharge, water quality, flood water conveyance and storage, and shoreline and erosion protection. Since wetlands depletion has been recognized as a national concern, efforts to protect wetlands have helped to slow the rate of wetland losses. Estimates of annual wetland losses in the conterminous United States have declined from approximately 180,000 wetland hectares from the 1950s to mid-1970s to approximately 116,000 hectares from 1974 to 1983. And new information compiled in America's farmbelt from 1982 to 1991 indicates a further reduction in the rate of wetland losses due to agricultural conversions. The U.S. government, states and private organizations have developed programs to make progress toward a national goal of no overall net loss of wetlands by protecting existing wetland resources and by taking advantage of opportunities to restore or create wetland systems.

Oceans and Coastal Resources

The states and insular areas of the United States have a total of over 20,800 kilometers of coastline. Over 20,000 species of fish and shellfish inhabit marine and freshwaters; approximately 300 species are fished by commercial and recreational fishermen. Commercial marine fishery products contribute over $16 thousand-million to the GNP. The outer continental shelf supplies more than 10 percent of domestic oil production and 25 percent of domestic natural gas production. Several marine sanctuaries and reserves have been set aside to ensure protection of certain living marine resources. In addition, federal and state agencies are addressing a variety of issues to ensure better management of all marine resources.

In 1990, 40 percent of Americans, approximately 110 million people, lived within 80 kilometers of a coastline, and the number is increasing. A consequence of population concentration in coastal areas is the growing problem of marine pollution by sewage disposal, urban runoff and marine debris. Industrial manufacturing and processing plants, landfills, dock and marina structures, and littering by the general population also contribute to marine pollution problems. Management plans for coastal zones address these

concerns. Since 1972, the United States has spent many thousands of millions of dollars to build sewage treatment plants that combat pollution in coastal waters.

Land and Mineral Resources

The total land area of the United States is nearly 920 million hectares and encompasses wide variations in environment, from forest to desert to tundra. Major uses of land are for grassland, pasture and range; forestland; and cropland. Fifteen percent of the land is engaged for special uses, including wildlife areas, parks and wilderness, and urban areas.

Nearly 320 million hectares are public lands. Federal, state and local agencies manage these lands for multiple uses, including recreation, wildlife habitat, timber and mineral production, research and other purposes. Some issues facing land managers include managing pollution impacts, minimizing the effects of habitat fragmentation, and managing public lands for increased recreation usage.

The nonfuel minerals sector of the economy furnishes raw materials on which the remainder of the U.S. industrial base depends. The nation is fairly self-sufficient in construction, fertilizer and chemical minerals. Nearly half the land utilized by the mining industry between 1930 and 1980 has been restored to some degree.

Plants, Animals and Biodiversity

During the past 20 years, evidence has grown, both within the United States and worldwide, that the diversity of life at all levels is being eroded. Sustainable human economic activity is dependent upon understanding, protecting and maintaining biodiversity. In the early 1970s, U.S. protection efforts focused on the preservation of endangered species. Almost all available federal data are on individual species with limited information on the status of ecosystems. There are 598 species listed as threatened or endangered. Managing habitat on an ecosystem scale is key to species protection; without adequate habitat, recovery of species now on the endangered list is difficult, if not impossible. Ultimately it is habitat, not species, that will need to be managed.

Current challenges that the United States faces in protecting biodiversity include: enabling institutions to better recognize an ecosystem management approach; increasing understanding of the impacts of decisions made in every sector of society; and addressing the increasing demand for better information.

Toxic Substances

The use of toxic chemicals brings great benefits to society as well as risks to human health and the environment. There are some 60,000 chemical compounds, many of undetermined toxicity, in use in the United States. An estimated 1.2 thousand-million kilos of pesticides, chemicals which are toxic by design, are used in the United States each year. While stimulating agricultural productivity, these chemicals can contaminate sources of drinking water, threaten the health of workers exposed to the chemicals, and affect consumers of food and a wide range of products. Pesticides policy emphasizes replacement of older, more toxic pesticides with newer and safer ones and with non-pesticide approaches to integrated pest management.

Many chemicals in use in the United States were introduced before the advent of federal environmental protection laws. Many have not been tested to determine whether they pose a threat to health or the environment. New approaches that focus on pollution prevention are being used in order to achieve more rapid and permanent change. Information is a key to new approaches. The Toxics Release Inventory, created in 1987, contains annual data from some 20,000 facilities on more than 300 chemicals. It is widely used by industry, states and environmental groups as a benchmark for

prevention efforts. Voluntary industry action, revitalized government programs and consumer action are also key components of new approaches.

Wastes

The federal and state governments have undertaken a sweeping program to revolutionize both hazardous and nonhazardous waste management. In recent years, pollution prevention has moved to the forefront in U.S. thinking on the management of the nation's wastes.

Federal and state agencies regulate the transportation, storage and disposal of 240 million tons per year of industrial hazardous wastes from over 200,000 generators. In 1988, 180 million tons of municipal solid waste were generated in the United States, equivalent to 1.8 kilos per person per day. Municipal waste management methods include source reduction, recycling, waste-to-energy conversion, incineration and the use of landfills. Recycling accounted for 13 percent of the municipal waste stream in 1988.

More than 35,000 potentially hazardous abandoned waste sites have been identified. Of those, over 1,200 sites have been placed on the National Priorities List, and cleanup costs are managed through a special trust fund, with responsible parties ultimately liable. Many wastes are now banned from land disposal if they have not been treated to specific standards. On another front, the federal government regulates some two million underground storage tanks, of which 20 percent are estimated to leak or are likely to leak.

Biotechnology

Biotechnology is the use of various biological processes to make products and perform services from living organisms or their components. The new biotechnology revolution began in the 1970s and 1980s when scientists learned to alter precisely the genetic constitution of living organisms. The techniques have spawned an industry comprising more than 550 new firms, more than 200 established firms that have diversified into biotechnology, and more than 400 supply firms in the United States alone. The new biotechnology industry in the United States produces pharmaceuticals, diagnostic tests and agricultural products worth over $2 thousand-million annually.

In 1990, principles of regulatory review were established to ensure that regulations and guidelines affecting biotechnology are based solely on the potential risks and are carefully designed to avoid excessive restrictions that could curtail the benefits of biotechnology to society. The principles will ensure that health and environmental quality are safeguarded while the great benefits of biotechnology are made available in the United States and worldwide.

ENVIRONMENTAL EMERGENCIES

Chapter 7 discusses the evolution of response, preparedness and prevention activities with respect to environmental emergencies and natural disasters over the last two decades. The United States has learned and accomplished a great deal in the past 20 years in preventing, preparing for, and responding to emergencies and disasters, both natural and human-caused. Building on a history of voluntary response efforts, the United States has developed a network of community, state and federal programs throughout the nation to plan for, and respond quickly and efficiently to, a wide variety of environmental hazards and emergencies. The United States has been a world leader in the development of capabilities for predicting natural hazards such as tropical cyclones, volcano eruptions and earthquakes, and combatting their effects.

Provisions authorizing a response to emergencies were first included in legislation during the 1970s and early 1980s. For example, the Federal Water Pollution Control Act (1972) and the Comprehensive Environmental Response, Compensation and Liability Act (1980) both provide response authority to address the release of oil or hazardous substances. Over the last decade, however, the United States has shifted its emphasis toward preparedness. The enactment of the Emergency Planning and Community Right-to-Know Act of 1986 not only requires local communities to plan and prepare for chemical accidents, but also strengthens their role in the preparedness process. More recently, the Clean Air Act Amendments of 1990, which recognize the broad-based nature of existing chemical activities, establish an important legislative basis for accident prevention in the 1990s.

While the United States has established and begun to refine a comprehensive preparedness and response system over the last 20 years, individual incidents continue to result in a reexamination of existing response and preparedness procedures. In two 1989 examples, the Loma Prieta Earthquake in California and the *Exxon Valdez* oil spill in Alaska have each caused a painstaking investigation and debate over the adequacy of the relevant prevention and response systems, and over the proper roles and responsibilities of various parties.

ENVIRONMENTAL IMPACT ASSESSMENT

Chapter 8 highlights the environmental impact assessment process, which integrates environmental decision-making with the policy set forth in the National Environmental Policy Act (NEPA). Passed in 1969, NEPA marked the first comprehensive federal environmental law in the United States. NEPA set the precedent to "impress and implant on the federal agencies an awareness and concern for the total environmental impact of their actions and proposed programs." It represents this nation's effort to anticipate environmental problems and prevent them.

To carry out this new environmental policy, Congress directed the agencies of the federal government to ensure that environmental amenities and values are given appropriate consideration in decision-making by preparing "detailed statements," or assessments, on the environmental impacts of all major federal actions significantly affecting the quality of the human environment. The environmental impact assessment process has two principal purposes: (1) integrating environmental considerations into the federal decision-making process, and (2) encouraging participation by the public and by federal agencies with specialized expertise in the preparation of environmental impact statements and in eventual decisions.

ENVIRONMENTAL EDUCATION

In the last 20 years, U.S. consumers have acquired a greater understanding of the environment and of the impact of personal behavior on the environment. Chapter 9 underscores the importance of education to achieve environmental objectives, and highlights an array of efforts targeted at all ages by diverse groups, including government, industry, schools and environmental organizations. It also provides an overview of environmental education programs and initiatives at every tier of society in the United States over the past two decades.

Several sources of environmental information are currently available, and the vast amount of informational sources emphasize the heightened

public awareness and national concern about environmental protection in recent years. This growing interest has led to legislative action such as the National Environmental Education Act, enacted in November 1990, which seeks to foster collaboration between the federal government and existing institutions such as the media, private industry, schools, museums, libraries, parks and recreation facilities.

Current issues of concern in developing effective environmental education programs include: communicating risk information, training teachers, infusing environmental subject matter into the broader curriculum, and evaluating the effectiveness of education efforts.

Endnotes:

1. U.S. Environmental Protection Agency, *Environmental Investments: The Cost of a Clean Environment*, November 1990.
2. Ibid.

PART I

THE PEOPLE OF THE UNITED STATES

CHAPTER

1

U.S. POPULATION AND THE ENVIRONMENT

Overview

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Immigration

■

U.S. Population Distribution

■

Level of Education and Economic Development

■

Health Status of U.S. Population

■

Environmental Stresses from Population Growth and Resource Consumption

■

Environmental Consequences of Future Population Distribution

OVERVIEW

The United States is populated by a diverse group of peoples whose ancestry can be traced to all corners of the world. With a total population of approximately 250 million in 1990, the United States is the fourth most populous country in the world, after China, India and the former Soviet Union. The majority of the population, 199.7 million people or 80.3 percent, are Caucasian descendants of immigrants from Europe, North Africa or Southwest Asia. African Americans number nearly 30 million (12.1 percent), while those of Asian and Pacific Island descent number 7.3 million (2.9 percent). Nearly two million Native Americans make up 0.8 percent of the population. Hispanic Americans number 22.4 million or 9.0 percent of the population.[1]

Average life expectancy at birth in 1990 in the United States was 75.4 years. The average infant mortality rate in 1990 was 9.1 deaths of infants under one year of age per 1,000 live births—half the level of 20 years ago and only about one fifth the infant mortality rate of 1940. Within these average numbers, however, there are significant variations. For example, the infant mortality rate for black infants in 1988 was double that for white infants—17.6 as opposed to 8.5. Even higher levels of infant mortality persist in some urban areas.

In recent decades, perhaps the greatest change in the U.S. population profile has been the downsizing and reconfiguration of the "traditional" family. Average family size in the U.S. declined from about 3.5 persons in 1950 to about 3.2 in 1985. In 1960, the "traditional" family—characterized by a married couple with a working male wage-earner, a woman who does not work outside of the household, and children raised at home accounted for approximately one-third of U.S. households. With the increase in the number of working women, incidence of divorce, and with 25 percent of all births occurring outside of marriage, the American family has changed significantly. By 1985 "traditional" families accounted for only one-ninth of all U.S. families. Working couples with or without children, adults living alone and single-parent as well as other types of households have increased in relative importance in American household structure. By 1985, 28 percent of all U.S. households were non-family households.[2]

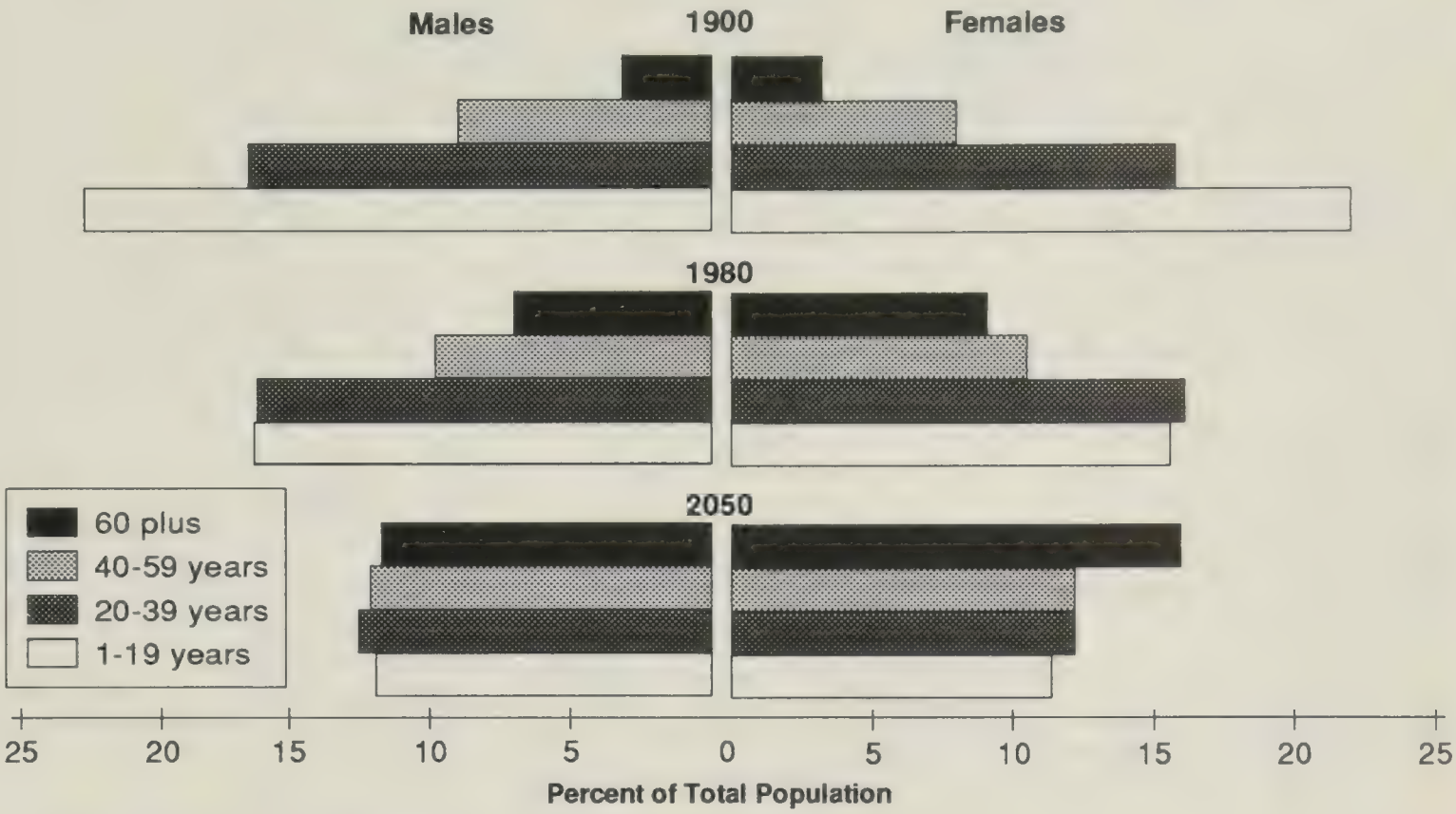
Changes in the roles and status of women from 1960 to 1980 and the near economic necessity of working couples have had substantial effects on the U.S. family structure. During this period it became the norm for women to work outside of the home for wages, in part out of economic need, and in part due to enhanced educational and economic opportunities for women. In 1960, only 37.7 percent of women worked outside the home; by 1985, 54.5 percent did so.[3]

In the late 1980s, the median U.S. household income was approximately $28,900, with a range of incomes extending significantly above and below this level. The incidence of poverty varies significantly by type of family. Married-couple families had the lowest poverty rates over the period, approximately six percent. Families with a single woman head of household had poverty rates of 32 percent. When these female-headed households also contained children below the age of 18, poverty rates were approximately 43 percent. In contrast, poverty rates for households of married couples with children younger than 18 years of age averaged seven percent. Household counts and poverty statistics do not include the number of U.S. citizens who are homeless. Estimates of the size of this group are inconclusive, but range from about 200,000 in acknowledged shelters to as many as 600,000 sheltered and unsheltered in both urban and rural areas.[4]

Although the current rate of U.S. population growth—0.7 percent annually—is significant, it is far below that experienced during the 1946 to

1964 "baby boom." That generation, which added 75 million people to the U.S. demographic profile, has had a sharp impact on school systems, job and consumer markets, and many other social and economic institutions. On the whole, the U.S. population is now aging. The median age of the total U.S. population rose by about four years from 1972 to 1989; in 1989 the median age was 32.6 years—31.5 years for males and 33.8 years for females. (See Exhibit 1.1)

Actual and Projected Change in Population Distribution
1900 - 2050



Note: Projections are middle series.

Source: U.S. Bureau of the Census, Decennial Censuses of Population, 1900-1980 and Projections of the Population of the United States; 1982 to 2050, Current Population Reports, Series P-26, No. 922, October 1982.

Exhibit 1.1

This "graying" of America portends many socioeconomic changes. As the "baby boom" generation reaches retirement age in the second and third decades of the next century, the relative numbers of younger, wage-earning citizens will decline. These changes will likely increase the number of persons dependent on the nation's health care and other social service programs, thereby increasing their costs relative to other programs and priorities. These demographic and economic changes will also have major impacts on public schools and other institutions that had been expanded in previous decades to accommodate the needs of large numbers of children and youth. (See Exhibit 1.2)

Population Growth. U.S. fertility has decreased significantly over the last 30 years largely due to the increased participation of women in the labor force and to widespread use of effective contraception among both males and females. In the 1950s, the average number of births per woman was 3.7.

U.S. women are currently bearing an average of 2.1 children. This is an increase from the 1.8 children per woman during the last decade, and results mainly from the decisions made by many women during the previous decade to delay childbirth.[5] The rate is predicted to decline to slightly less than two children per woman. However, the rate of natural increase (the excess of births over deaths) for the U.S. population has held steady over the past 20 years at about seven per 1,000 population, equivalent to a 0.7 percent growth rate annually. This rate is less than half the natural rate of increase of 15.7 per 1,000 in 1957, the peak of the last "baby boom." Had that rate of increase continued, the U.S. population would have doubled in 40 years. At today's rate of increase, the U.S. population will double in 75 years.

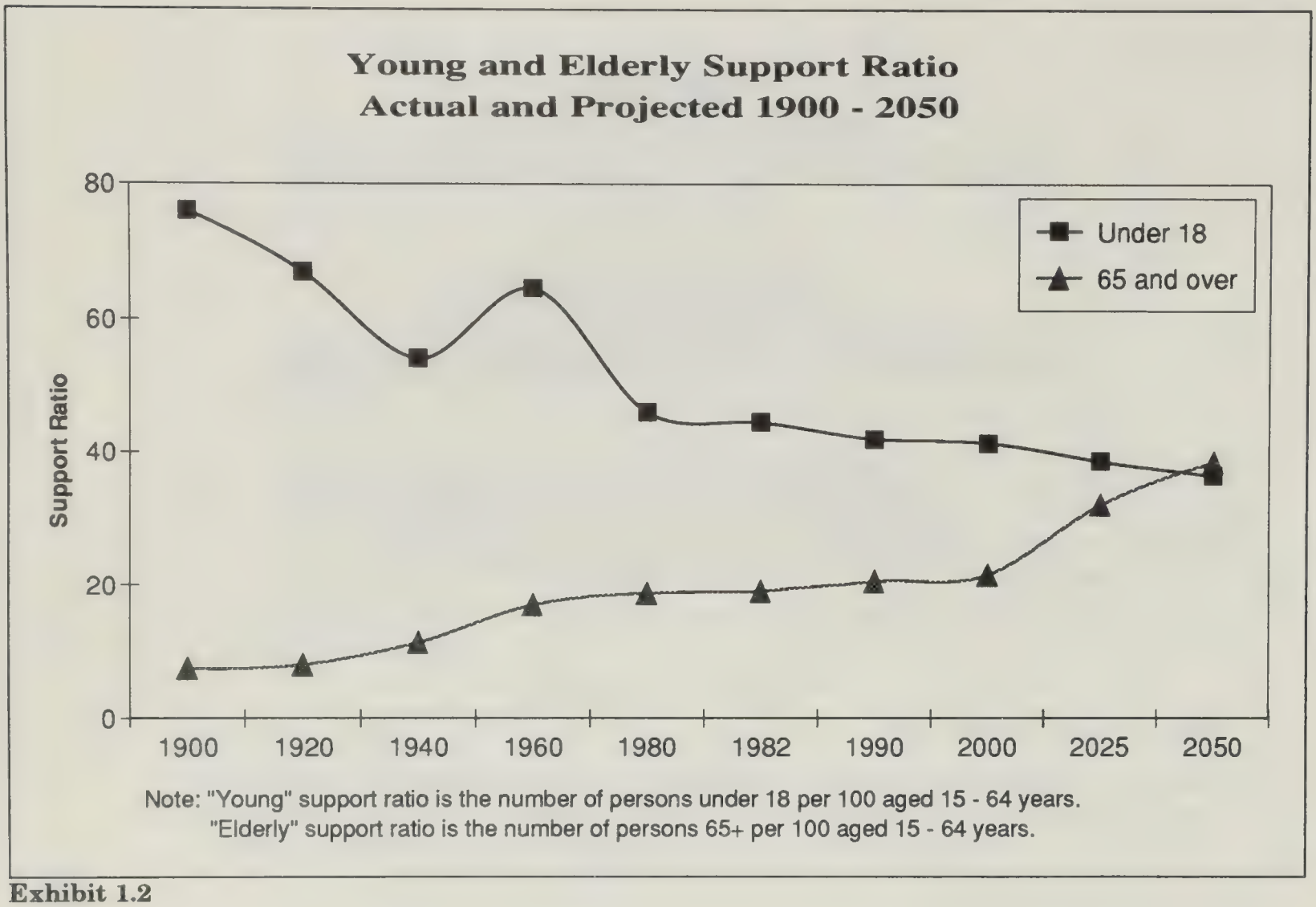


Exhibit 1.2

IMMIGRATION

Despite the low rate of natural increase, U.S. population has grown 22 percent from 1970 to 1991, due in part to immigration. Net immigration accounted for approximately 29 percent of population growth in the 1980s. This compares with 11 percent during the 1950s and perhaps 40 percent during the peak immigration years of 1900 to 1910, when there were no numerical limits on immigrants and the U.S. population was smaller.[6] In recent years, immigration has accounted for an increasing proportion of U.S. population growth, and the U.S. Immigration Act of 1990 ensures that immigration will remain at high levels during the next decade.

Immigration trends have changed. From 1820 to 1969, eight of every 10 immigrants admitted to the United States originated from Europe. Since 1970, however, only one of seven immigrants was European in origin.

Immigrants of Asian origin constituted 38 percent of total legal immigration from 1981 to 1990, while Latin America contributed 29 percent, and the Caribbean about 12 percent. Immigration has increased steadily since the end of World War II, averaging about 450,000 annually in the 1970s and over 600,000 annually in the 1980s. Net migration to the United States during the 1980s was 650,000 per year, as an estimated 200,000 net illegal resident aliens entered the United States and 150,000 former legal immigrants left.[7]

Of the 650,000 immigrants admitted annually during the 1980s, approximately 100,000 were refugees. From 1975 through 1990 the United States admitted 1.44 million refugees, most of them from Indochina, (Cambodia, Laos and Vietnam, 982,000), the former Soviet Union (220,000), and Eastern Europe (106,000). Current U.S. government plans would authorize refugee admissions to remain above 100,000 per year for the foreseeable future.

The size of the illegal resident alien population in the United States is difficult to quantify. The best available estimate is that the number is between two and three million, with a net increase of about 200,000 per year.[8] Illegal residents may have reached four to five million in 1986 before certain long-term illegal residents and agricultural workers were granted legal status under the legalization program authorized by the Immigration Reform and Control Act of 1986. Mexicans constituted 75 percent of the 3 million aliens who applied for legalization, followed by Salvadorans, Guatemalans and Colombians.

The sex distribution of legal immigrants is roughly equal, while male illegal immigrants are estimated to outnumber females by 10 to 20 percent. Over half of all immigrants admitted to the United States in 1990 were between the ages of 20 and 39 (compared with one-third of the general population); their median age was 30 years. Illegal immigrants, as a group, are younger, with an average age between 25 and 26. The median number of school years completed by legal immigrants is similar to that of the general U.S. population. However, the immigrant population includes a higher proportion of persons at both ends of the educational spectrum—those with either four or more years of college completed, or less than five years of elementary school.

Six large states are home to 75 percent of the immigrants admitted from 1984 to 1990: California, New York, Texas, Florida, Illinois and New Jersey. These same states contained 39 percent of the U.S. population in 1990. Socioeconomic consequences of immigration may be concentrated to the extent that immigrants tend to concentrate in a limited number of metropolitan areas. Nearly 35 percent of the legal immigrants admitted from 1984 to 1990 intended to reside in just three metropolitan areas: New York, Los Angeles and Chicago.

According to The President's first Triennial Report on Immigration ("The Effects of Immigration on the U.S. Economy and Labor Market", 1989), research on the labor-force effects of immigrants in the major immigrant cities indicates that U.S. natives have not experienced widespread job displacement due to immigration. Immigrants have found both entry-level and professional-level employment in these cities. English-language ability and training levels are more important to earnings levels than immigration status (legal, illegal or refugee). Self-employment of immigrants creates significant numbers of jobs. The presence of immigrants in the labor force is slightly larger in services than in manufacturing. Compared to native-born workers, however, immigrant workers are more concentrated in manufacturing, and often in sectors subject to the greatest levels of international competition, such as apparel, auto parts and footwear. While selected industries and groups of workers have been singled out for research on the effects of immigration, the

progressive internationalization of the economy and the many adjustments to this process have made it difficult to distinguish the independent effects of immigration.

Immigrants' destinations are determined by social networks as well as by economic factors. U.S. immigration law also encourages this type of migration by granting preferential entry to relatives of U.S. citizens and legal residents. As a result, about 75 percent of immigrants enter the United States based on their family relationships. Developing U.S. immigration policy, codified in the Immigration Act of 1990, retains a family reunification emphasis while authorizing immigration for more skilled workers. Debate over the bill focused on modifying the relative number and characteristics of immigrants who would be allowed to enter the United States. Although some analysts argue that the skill level of immigrants relative to natives has declined since the 1960s, economic evidence continues to demonstrate major national benefits from legal immigration. The new law expanded from 59,000 to 140,000 the number of principals and family members allowed entry on the basis of job skills. This change is intended to foster a better match between immigrants and anticipated labor market demands.

Most immigrants to the United States have become successfully integrated into the economic life of the nation; however, success varies by ethnic group. Authoritative research generally finds that the net effect of immigration is to increase the aggregate income of the native-born population, if only by small amounts. These economic effects are increasingly important as immigrant contributions to labor force growth increased from 12 percent in the 1970s to 22 percent in the 1980s, and will account for somewhat more in the 1990s.[9]

The more unskilled and poorly educated immigrants and refugees, particularly the illegal immigrants, have experienced some difficulties in economic integration. High unemployment and disenfranchisement are more common among these population groups. Accumulated tensions have emerged in the form of violent protests and demonstrations of civil unrest. Collaborative efforts at the local, state and national level are needed to integrate immigrant populations effectively into the economy without disenfranchisement of existing population groups.

U.S. POPULATION DISTRIBUTION

During the past 20 years, while overall population growth was moderate and steady, there was a wide variation among regions of the United States. Exhibit 1.3 shows the annual average population change by region for the period. Exhibit 1.4 shows the cumulative percentage increase in population by region.

Regional Trends

In 1989, the South was the most populous region (85.5 million), with just over 34 percent of the nation's population. Between 1972 and 1989, the South's population expanded by 19.7 million (29.9 percent) due to a relatively low cost of living and to inter-regional migration induced by the search for new employment. Generally, the rate of growth has slowed in the last 10 years to about half the rate at the start of the decade.

The West has been the most rapidly-growing region since at least 1970. Between 1972 and 1989, population in the region grew by 42.3 percent to 51.8 million, an increase of 15.4 million. The Midwest, with 60.1 million people in 1989, grew by 2.7 million (4.8 percent) between 1972 and 1989. The Northeast experienced a period of renewed growth in the 1980s after losing population between 1972 and 1980. Overall, population in the

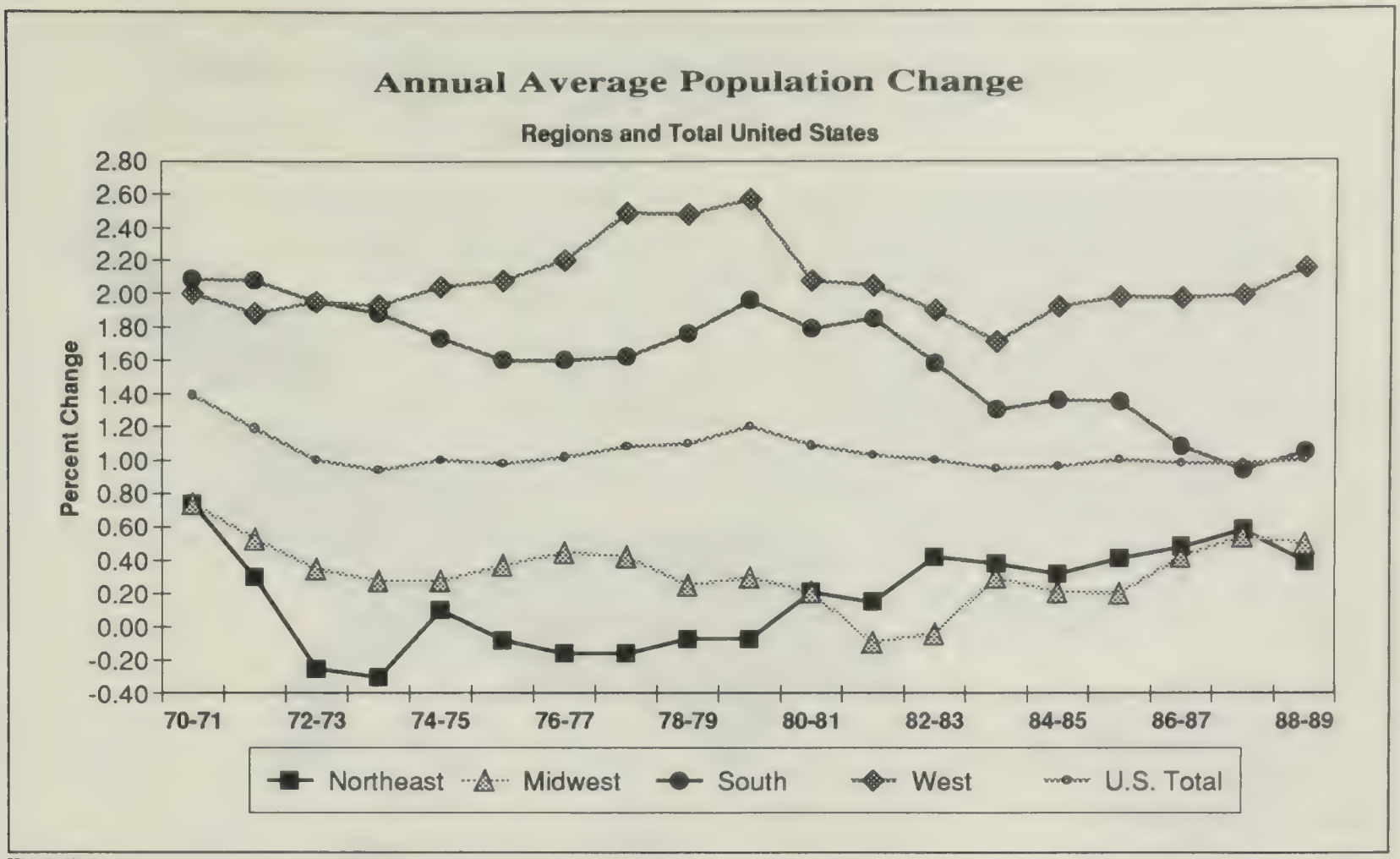


Exhibit 1.3

Northeast grew by 1.1 million or 2.2 percent between 1972 and 1989, reaching 51 million people.

Several major phenomena characterize the redistribution of population within the United States in the past 40 years:

- *Urbanization.* The United States was far more metropolitan in 1987 (77 percent) than in 1950 (56 percent). Large numbers of people moved from small towns and rural areas to large cities, creating areas of urban sprawl. The percentage of the U.S. population living in the larger metropolitan areas (over one million population) grew from 30 percent in 1950 to 50 percent in 1990.

- *Sunbelt Growth.* Growth in metropolitan population has been concentrated in the part of the United States known as the "Sunbelt," which includes the southern tier of states stretching from Florida to California. Much of the U.S. population distribution in recent decades has shifted from the North-Central and Northeast industrial belt to the Sunbelt states, which enjoy a much warmer climate. Nine of the 12 fastest growing metropolitan areas in 1990 were located in Florida.

- *Non-Farm Rural Growth.* In the past 20 years, a renewed interest in rural living has evolved. The rural population has increased by nearly 25 percent, to 66 million, and is increasing as fast as the metropolitan population.

- *Declining Farm Populations.* Farm residents make up only 1.9 percent of the total U.S. population, and 7.3 percent of the rural population. The farm population has been decreasing as a component of the rural

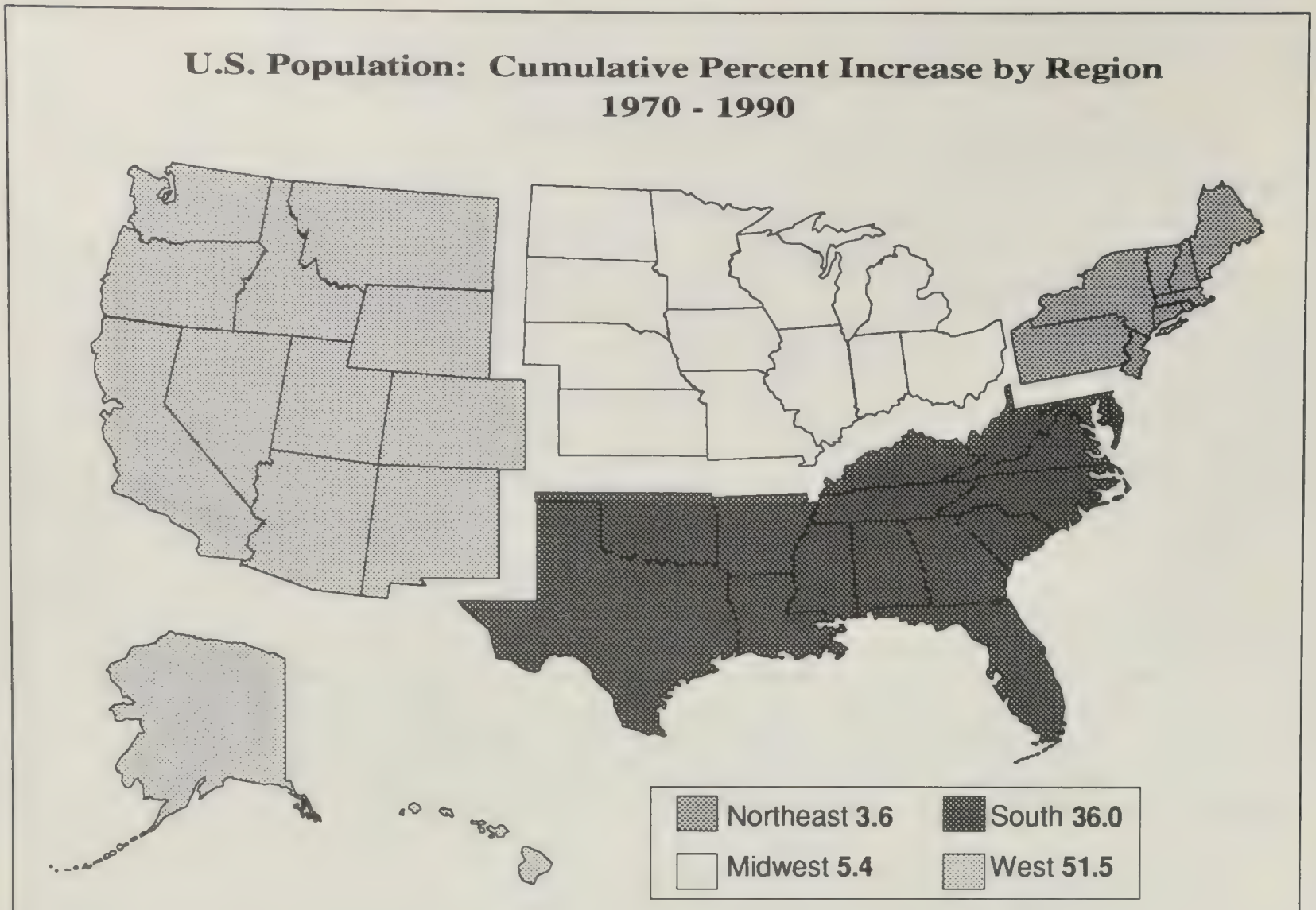


Exhibit 1.4

population. By definition, the farm population consists of all persons residing in rural territory on places from which $1,000 or more of agricultural products were sold in the previous 12 months. In 1989 the farm population stood at 4.8 million, a decline of 84 percent from the 1940 level. The following table compares the farm and non-farm portions of the rural populations for the past 50 years.

FARM AND NON-FARM POPULATIONS 1940-1989 (in millions)

Year	1940	1950	1960	1970	1980	1989
Rural	57.2	54.2	54.0	53.6	59.5	66.2
Non-Farm	26.7	31.2	38.4	43.9	53.5	61.4
Farm	30.5	23.0	15.6	9.7	6.0	4.8
Percent Farm	53.3	42.4	28.9	18.1	10.1	7.3

The South contains the largest share of the nation's rural population (28.9 million or 43.6 percent); the Midwest has the second largest rural population (17.7 million or 26.7 percent) followed by the Northeast (11.3 million or 17.1 percent) and the West (8.3 million or 12.5 percent). The relative regional distribution of the rural population has remained constant since 1950.[10]

The farm population has experienced a significant regional redistribution since 1950, however, evidenced by a notable decline in the South relative to the Midwest. The Midwest has about half the nation's farm residents (51.3 percent or 2.5 million residents). The differences in the regional distribution of the farm population between 1950 and 1989

can be attributed to an exceptionally large decline in Southern farm residents, down nearly 90 percent since 1950. Tenant farmer families emigrated to the North as machinery substituted for labor and farm sizes increased substantially.

- *Coastal Area Growth.* In contrast, the total population of coastal areas has continued to increase and in the environmentally fragile areas of the Southeast and Gulf regions, has grown faster than the population as a whole, heightening environmental concerns over the intensity of resource use and its impacts. Today, about 110 million people live in the coastal areas of the United States. Large numbers of non-coastal residents also depend on the coasts for recreation and employment. Coastal areas are some of the most densely populated and rapidly growing areas of the United States. In 1988, population density in coastal counties was more than four times greater than the overall U.S. average of 27 persons per square kilometer. In over 20 percent of the nation's coastal counties, density exceeds 192 persons per square kilometer, with the urban centers surrounding New York, San Francisco, Boston and Philadelphia exceeding 3,846 persons per square kilometer.

  The most densely populated portion of the country's coastal zone is the Northeast, which accounts for more than one-third of the nation's coastal population. In 1988, the 134 coastal counties in this region, stretching from Maine to Virginia, were home to more than 39 million people, about 16 percent of the nation's total population.

  Exhibit 1.5 compares the total and coastal populations in 1970 and 1990 of the five major coastal regions of the United States that border on the Great Lakes, the Gulf of Mexico, and the Atlantic, the Pacific, and the Arctic Oceans. These regions encompass 30 states. The 451 "coastal" counties of these states account for 20 percent of the nation's total land area (11 percent excluding Alaska).

  These 30 coastal states account for nearly 83 percent of the total U.S. population, while the coastal counties are roughly 55 percent of the population of these states. Continued population growth in coastal areas is leading to increased crowding and environmental degradation in this small portion of the nation's total area. Significant losses of habitat and living resources, increased demands for water, energy, and waste treatment and disposal, and diminished environmental quality in many areas present challenges to public and private efforts to manage the sustainable development of resources in coastal areas. (See Chapter 6 on oceans and coastal resources.)

LEVEL OF EDUCATION AND ECONOMIC DEVELOPMENT

The educational attainment of young adults has increased over the past 45 years. By 1986 only 13.6 percent of white Americans aged 25 to 29 and 15.7 percent of black Americans had completed less than four years of high school. In contrast, 41 percent of Hispanic Americans of the same age group, many of whom were recent immigrants, had completed less than four years of high school. The proportion of all young adults completing four years of college has not changed significantly since 1975.

The proportion of minority students enrolled in school at all levels (including college) has increased from 1975 to 1985. Total enrollments of black Americans at the elementary and secondary levels increased from 14.5 percent to 15.8 percent of all students; enrollments of Hispanic Americans increased from 6.5 percent to 9.7 percent.

MAJOR COASTAL REGIONS OF THE UNITED STATES

Region	Population 1970 Total Coastal (Coastal %) *(Thousands)*	Population 1990 Total Coastal (Coastal %) *(Thousands)*	Percentage Change
Northeast (Atlantic)	**58,496**	**61,984**	**+6**
	37,323	39,053	+5
	(64%)	(63%)	-1
Great Lakes	**74,111**	**76,052**	**+3**
	19,855	18,892	-5
	(27%)	(25%)	-2
Southeast (Atlantic)	**19,054**	**29,425**	**+54**
	5,257	9,131	+74
	(28%)	(31%)	+3
Gulf of Mexico	**27,296**	**41,800**	**+53**
	9,006	14,726	+64
	(33%)	(35%)	+2
Pacific Region	**26,548**	**38,254**	**+44**
	21,500	29,840	+39
	(81%)	(78%)	-3

Source: 1970 statistics, U.S. Bureau of the Census; 1990 statistics, National Planning Association Data Services, Inc. Both cited in *50 Years of Population Change along the Nation's Coasts, 1960-2010*, by Thomas J. Culliton, et al., Rockville, MD: National Oceanic and Atmospheric Administration, April 1990.

Exhibit 1.5

Between 1970 and 1985, the percentage of young men aged 16 to 24 dropping out of high school decreased from 14.2 percent to 13.4 percent. The corresponding figure for young women decreased from 15.7 percent to 11.8 percent. Rising school completion rates for women accompanied significant changes in female labor force participation. With increased levels of education and increased participation in the labor force, women are playing a larger role in U.S. economic life than ever before. Greater numbers of women and minorities are enrolled in postsecondary educational programs in non-traditional fields. They are actively recruited for faculty positions, where they can be effective role models for future students.

The median number of school years completed by recent immigrants, is similar to that of the general U.S. population. However, the immigrant population has included a higher proportion of persons at both the upper and lower ends of the educational spectrum (those with four or more years of college completed, and those with less than five years of elementary school).

Labor Force Participation

The U.S. market economy created a remarkable number of jobs as the labor force grew from 82.8 million to 124.8 million persons between 1970 and 1990. (See Exhibit 1.6.) The participation of the working age population (16 years old and over) in the paid labor force rose consistently. In 1990, 66.4 percent of the civilian population was in the labor force, compared with 60.4 percent in 1970.

Expansion was due both to an increase in the working age population and in the rates of labor force participation among some population groups,

SIZE AND PERCENT DISTRIBUTION OF THE CIVILIAN LABOR FORCE BY SEX AND AGE

Sex and Age	1970	1980	1990
Total, in thousands	82,771	106,940	124,787
	Percent distribution		
Total	100%	100%	100%
Men, 16 and over	**61.9%**	**57.5%**	**54.7%**
16-19	4.8	4.7	3.1
20-24	6.9	8.0	5.8
25-34	13.7	15.9	15.9
35-44	12.6	11.1	13.8
45-54	12.6	9.3	9.0
55-64	8.6	6.8	5.4
65 and over	2.6	1.8	1.6
Women, 16 and over	**38.1%**	**42.5%**	**45.3%**
16-19	3.9	4.1	2.8
20-24	5.9	6.8	5.3
25-34	6.9	11.5	12.8
35-44	7.2	8.1	11.7
45-54	7.9	6.5	7.5
55-64	5.0	4.4	4.1
65 and over	1.3	1.1	1.2

Source: U.S. Department of Labor.

Exhibit 1.6

particularly women. The proportion of women in the labor force increased from 43.3 percent in 1970 to 51.5 percent in 1980 and 57.5 percent in 1990. (See Exhibit 1.7.)

The median age of civilian workers dropped between 1970 and 1980, but then began to rise again. The share of the overall labor force aged 25 to 44 years rose from 40.4 percent to 54.2 percent between 1970 and 1990, reflecting the entry of "baby boomers" born from 1946 to 1962 as well as increasing numbers of women. On the other hand, there was a decided drop in the percentage of the labor force aged 45 and over—from 38.0 percent in 1970 to 28.8 percent in 1990.

According to the most recent projection by the U.S. Department of Labor, the rate of labor force participation is likely to rise further in the 1990s. It is projected that, by 2000, 69 percent of the total population aged 16 and over will be in the labor force, up from 66.4 percent in 1990. The overall participation rate for women is expected to rise from 57.5 percent to 62.6 percent in the coming decade, while that for men is expected to fall marginally from 76.1 percent to 75.9 percent in the period 1990 to 2000. Among men aged 55 to 64, labor force participation has been declining, down from 83 percent in 1970 to 67.7 percent in 1990. As a result of these countervailing trends, women have increased their share of the U.S. work force by seven percentage points since 1970.

CIVILIAN LABOR FORCE PARTICIPATION RATES BY SEX AND AGE, 1970 TO 1990 *

Sex and Age	1970	1980	1990
Both sexes, 16 and over	**60.4**	**63.8**	**66.4**
Men, 16 and over	**79.7**	**77.4**	**76.1**
16-19	56.1	60.5	55.7
20-24	83.3	85.9	84.3
25-34	96.4	95.2	94.2
35-44	96.9	95.5	94.4
45-54	94.3	91.2	90.7
55-64	83.0	72.1	67.7
65 and over	26.8	19.0	16.4
Women, 16 and over	**43.3**	**51.5**	**57.5**
16-19	44.0	52.9	51.8
20-24	57.7	68.9	71.6
25-34	45.0	65.5	73.6
35-44	51.1	65.5	76.5
45-54	54.4	59.9	71.2
55-64	43.0	41.3	45.3
65 and over	9.7	8.1	8.7

* The numbers shown represent the percentages of the population which are in the civilian labor force, and either working or looking for work.
Source: U.S. Department of Labor.

Exhibit 1.7

The increase in labor force participation has been most striking among women of childbearing ages. The proportion of working age women who work outside the home rose from 43.3 percent in 1972 to 57.5 percent in 1990; the rate for married women with preschoolers increased from 30.3 percent to 58.9 percent over this period. Among women 25 to 34 years of age, for example, the rate of labor force participation nearly doubled over the past 25 years, and now approaches 75 percent.

Even by the year 2000, the population and the labor force of the United States will continue to be concentrated in the central age range, a trend which should shift upward slightly as the labor force ages. Workers will likely have to work longer than they do at present as there will be fewer young to support the retirement programs and health costs will grow as the "baby boomer" generation ages.

Employment opportunities for women and minorities continue to expand, supported by population shifts to metropolitan areas. There is, however, still a marked difference in salary and opportunities for advancement for these groups. The gap between earnings by men and women has narrowed in recent years, a trend expected to continue. The median weekly earnings for women working full time in 1990 was $348, which was 72 percent of the median for men. However, during economic recession, women and minorities tend to be the first workers laid off because of lack of seniority.

Since many immigrants are of prime working age, they have become a larger proportion of the work force, and will likely continue to be so as the U.S. population ages. For example, largely because of immigration, the

number of Hispanic Americans in the labor force has grown from 6.1 million in 1980 to 9.6 million in 1990. At the aggregate economic level, studies have shown that immigrants are successfully absorbed into the labor market. Their absorption is generally attributed to the small number of immigrants relative to the total population, domestic migration and labor force expansion. In the 1990 Economic Report of the President, the Council of Economic Advisers concluded that immigration plays a relatively small role in long-term employment growth and in the adjustment of the overall economy to changing conditions.

Nevertheless, the contribution of immigrants to labor force growth in the 1980s has had the most impact on population groups competing for jobs on the lower end of the labor market. Generally, immigrant labor has accepted those jobs least wanted by other population groups, such as transient labor in agriculture. They may also replace other workers in domestic household, service and janitorial positions. In some localities this has begun to heighten racial and ethnic group tensions.

One of the most striking aspects of the U.S. work force is the small proportion—fewer than three percent in 1990—engaged in agricultural tasks as a primary activity, although the United States still is one of the largest agricultural producers in the world. Overall, agriculture in the United States is resource-intensive—but not labor-intensive, except for the harvesting of certain fruits, a task for which immigrant workers are disproportionately employed. Another notable development has been a decline in the percentage of workers employed in manufacturing industries, down from 27 percent in 1970 to 17 percent in 1990. Concurrently, the proportion of workers in managerial and professional specialties and technical, sales and administrative occupations rose from 48.4 percent in 1972 to 57.1 percent in 1990, indicating the further transition of the United States from a manufacturing to a service economy. Exhibit 1.8 presents a profile of the non-farm wage and salary work force by industrial sector.

Income Distribution (1972 to 1989)

After adjusting for inflation using the Bureau of Labor Statistics (BLS) experimental price series that accounts for homeowner costs, household income in 1989 was 6.7 percent higher than the comparable 1972 median and 10.1 percent higher than in 1981. The relatively small change over the period (shown in Exhibit 1.9) masks the sharp changes that occurred during the interval. Recessionary periods in the 1970s and early 1980s resulted in declines in real (adjusted for inflation) household income. The first of these recessions, from November 1973 to March 1975, resulted in a 5.7 percent decline in real household income from 1973-1975. The second and third recessionary periods, from January 1980 to July 1980 and July 1980 to July 1981, resulted in an overall decline in household income of 5.1 percent from 1979 to 1982. Since 1982, in contrast, real household income increased a total of 10.5 percent.

Per capita income adjusted for inflation using the BLS experimental index (also shown in Exhibit 1.9) grew 22 percent in real terms. The increase was larger than household income because it reflects both the growth in overall income and the decline in average household size over the period.

A commonly used statistic to measure income distribution is the share of aggregate income received by each fifth of the population. In 1989, the share of income received by the highest fifth of families (shown in the right side of Exhibit 1.9) was 44.6 percent, significantly higher than the comparable figure for 1972. The change was accompanied by somewhat lower shares going to the lowest and middle three fifths. Part of the change in income distribution can be attributed to the changing composition of families such as the growth in the number of elderly families and families with a female head

DISTRIBUTION OF NON-FARM PAYROLL EMPLOYMENT BY MAJOR INDUSTRY, 1970 TO 1990

Industry	1970	1980	1990
Total, in thousands	70,880	90,406	109,971
	Percent distribution		
Total	100%	100%	100%
Goods production	**33%**	**28%**	**23%**
Mining	1	1	1
Construction	5	5	5
Manufacturing	27	22	17
Services	**67%**	**72%**	**77%**
Transportation & Public Utilities	6	6	5
Wholesale	6	6	6
Retail	16	17	18
Finance, Insurance & Real Estate	5	6	6
Services	16	20	26
Government	18	18	17

Source: U.S. Department of Labor.

Exhibit 1.8

of household and no husband present. Other factors, such as the aging of the baby boom generation, the growth in the labor force participation of women, and the changing occupational structure may also contribute to the distribution pattern.

Median household income in the United States is highly variable by group. While the overall figure for 1989 was $28,900, that single figure is not representative of most segments of the U.S. population. For example, the 1989 median income for white households was $30,400, considerably higher than that for black households ($20,200) and Hispanic households ($21,900). Households headed by single females had a median income of $15,700; those headed by single black females had a median income of less than $10,000. The median income by age of the head of household in 1989 was:

Age	15-24	25-34	35-44	45-54	55-64	65 and over
Median Income	$18,700	29,800	37,600	41,500	30,800	15,800

The median household income increases dramatically well into middle age. It reaches its highest level for those aged 45-54, and then declines.

The incidence of poverty tends to fluctuate cyclically; years of economic growth are characterized by drops in both the number of poor and poverty rates.[11] (See Exhibit 1.10.) The number of persons below the official poverty level constituted 11.9 percent of the population in 1972 and 12.8 percent in 1989. During the 1970s, changes in the number of poor people were relatively small, with the poverty rates varying between 11.1 and 12.6 percent. From 1978 to 1983 the number of persons in poverty increased by 10.8 million to a

INCOME SUMMARY MEASURES

Year	Median Household Income (in 1989 dollars)	Per Capita Capita Income (in 1989 dollars)	Share of total family income received		
			Lowest fifth	Middle three fifths	Highest fifth
1989	28,906	14,056	4.6	50.8	44.6
1988	28,537	13,755	4.6	51.4	44.0
1987	28,447	13,525	4.6	51.6	43.8
1986	28,168	13,203	4.6	51.6	43.7
1985	27,218	12,692	4.7	51.8	43.5
1984	26,751	12,326	4.7	52.3	42.9
1983	26,187	11,887	4.7	52.5	42.8
1982	26,163	11,648	4.8	52.5	42.7
1981	26,251	11,665	5.1	53.1	41.8
1980	26,683	11,733	5.2	53.3	41.5
1979	27,583	12,011	5.3	53.1	41.7
1978	27,673	11,858	5.3	53.2	41.5
1977	26,629	11,350	5.3	53.3	41.4
1976	26,483	11,003	5.5	53.5	41.1
1975	26,036	10,631	5.5	53.5	41.1
1974	26,752	10,620	5.6	53.5	41.0
1973	27,616	10,879	5.5	53.4	41.1
1972	27,082	10,526	5.5	53.3	41.4

Exhibit 1.9

total of 35.3 million. The poverty rate and the number of poor people have declined since then, although not falling back to their 1978 levels.

Poverty rates in the United States have always been significantly lower for whites than for blacks and Hispanics. (See Exhibit 1.10) Poverty rates for blacks ranged from 30.3 to 35.7 percent between 1972 and 1989 compared with poverty rates for whites of 8.4 percent to 12.1 percent. The poverty rate for Hispanics ranged from 21.6 to 29.9 percent.

The proportion of the poor who were children or elderly declined from 57 percent in 1972 to 50 percent in 1989. The percentage of children under 18 living below the poverty rate actually increased from 14.9 percent in 1972 to 19 percent in 1989. The proportion of the elderly living in poverty dropped below the poverty rate for all persons in 1982. However, in 1989, one in five persons whose income was within 25 percent above the poverty level was elderly, compared with about 1 in 10 persons below the official poverty level.

The incidence of poverty varies significantly by type of family. Married couple families had the lowest poverty rates, over the period, ranging from 5.2 percent to 7.6 percent. Families with a single female householder had poverty rates ranging from 30.4 percent to 36.3 percent. Families with children under 18 who are headed by females had poverty rates ranging from 39.6 percent to 47.8 percent, compared with 5.9 percent to 10.1 percent for married couple families with children under 18.

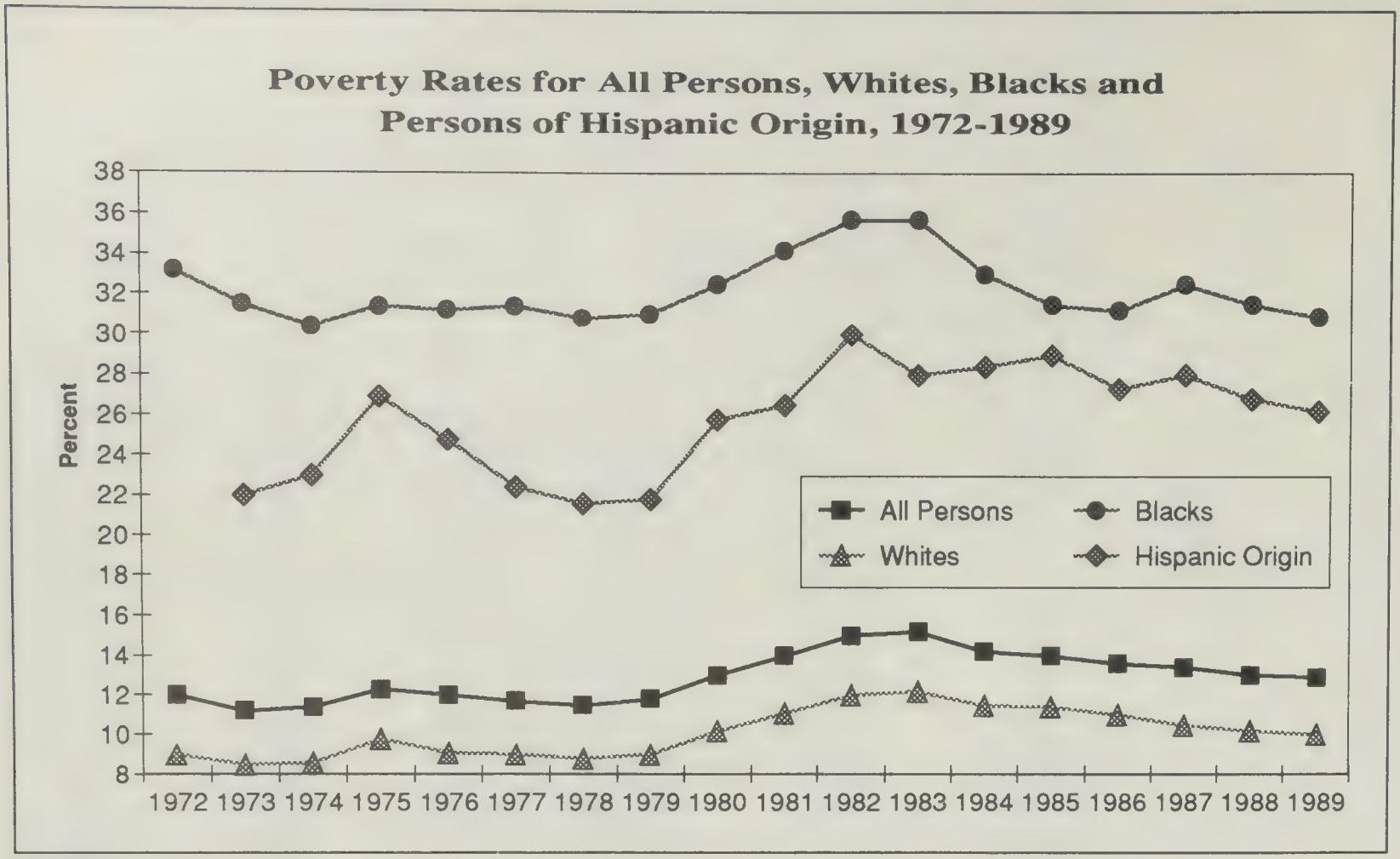


Exhibit 1.10

HEALTH STATUS OF U.S. POPULATION

In 1990 the average life expectancy at birth in the United States was 75.4 years of age, due in part to the high standard of health care available to most U.S. residents. National spending on health care in 1990 was $666.2 thousand-million, 12.2 percent of the Gross National Product (GNP), up from 11.6 percent in 1989 and from 5.3 percent in 1960. The 1990 figure represents the highest proportion of GNP spent on health care of any developed nation. Of total health expenditures, 38 percent went for hospital care, 19 percent for doctors, and eight percent for nursing home care. About 35 percent of all bills were paid by patients, 29 percent by private businesses, and 33 percent by the federal and state governments. Most public spending was accounted for by two major federal programs: Medicare, which provides comprehensive health care for the elderly; and Medicaid, the jointly funded federal-state program to assist low-income people with medical costs. Personal health care expenditures per capita were $2,255 in 1990.[12] The vast majority of Americans have some form of health insurance, mostly through their employers. About 13 percent, or 34,000,000 American citizens, do not have health insurance.

Health Issues

Long-term trends in mortality in the United States continue to be favorable. Improvements in mortality are largely the result of declines in chronic diseases. Trends in mortality have not, however, moved uniformly downward on a year-to-year basis. Annual mortality increases have resulted from trauma, drug abuse and AIDS.

Illicit Drugs. Use of illicit drugs remains an area of particular concern. In 1988, approximately 21 million Americans had tried cocaine at least once, and 66 million had used marijuana in the past. A 1990 survey of high school seniors indicated that the percentage using cocaine and crack had dropped, compared to 1985 and 1980 surveys.[13] Not only has illicit drug use become a

national health problem, but drug-related deaths claim a large number of U.S. youth who are involved in the sale and/or use of drugs, and of innocent bystanders who are often the victims of drug-related crimes.

Public programs aimed at reducing illicit drug use and sales are widescale on the federal, state and local levels. However, the focus of many of these programs, particularly on the federal level, is on crime prevention and apprehension. Drug rehabilitation programs have been initiated, but are costly, and compete for funding with other health care costs. Studies are underway to evaluate the relative value of increasing the priority given to rehabilitation programs.

Alcohol and Cigarettes. The overall trend in consumption of alcoholic beverages is down since 1978; about nine percent of adults consume more than two alcoholic beverages each day. Alcohol abuse is implicated in nearly half of all suicides, homicides and deaths caused by motor vehicle crashes.

The prevalence of cigarette smoking fell to 29 percent by 1987, down from 40 percent in 1965. Smoking was somewhat more common among people with a high school education or less (34 percent), black adults (34 percent) and Hispanic adults (33 percent).

AIDS. AIDS has risen as a cause of death in recent years. In 1990 human immuno-deficiency virus (HIV) infection was the eleventh leading cause of death, up from 1988 when it was the fifteenth leading cause of death. Among adult and adolescent men, the percentage of all transmissions of AIDS/HIV attributable to homosexual and bisexual contact dropped from 70 percent to 66 percent from 1984 to 1988. Among adult and adolescent women, intravenous drug abuse accounted for 62 percent of HIV infection in 1984 but only 53 percent in 1988. Transmission through the general population by heterosexual contact rose from 17 percent to 26 percent. These trends are likely to continue. The use of condoms as an AIDS prevention measure is promoted in both public and private sector AIDS programs. Social taboos and cultural preferences are being overcome as the public's awareness is heightened to the risks of AIDS transmission. First thought to be limited to the homosexual community, the incidence of AIDS in the broader population has dispelled much of this misunderstanding of the disease.

Prenatal, Infant and Child Care. Another issue is the need to improve prenatal care for low-income women and immunizations for low-income children. Also U.S. officials are concerned that for mothers of all races smoking and alcohol consumption during pregnancy leads to increased rates of fetal injury, premature birth and low birth weight.

In 1983, the United States reached its highest level of coverage from vaccines against all five of the common preventable childhood diseases—measles, rubella, DPT, polio and mumps. Ninety-seven percent of children entering school for the 1987-88 school year had received their basic immunization series. A recent increase in the incidence of measles and mumps suggests that the fully immunized population of children may be declining, however.

Family Planning. In the United States domestic voluntary family planning programs, which consist of a wide variety of contraception options including natural family planning, are very active. In 1990 approximately 69 percent of the 58 million women of childbearing age (ages 15 to 44) in the United States were using some form of contraception. The leading method of contraception among U.S. women is the use of birth control pills. The second most common method is female sterilization, followed by the condom and male

sterilization. However, male and female sterilization, when considered as a single category of contraception,n is the leading family planning method in the United States.[14]

Organized family planning service providers are financed through both public and private sources. Federal funding for such services in fiscal year 1989 came primarily from four separate programs: Title X of the Public Health Services Act, the Maternal and Child Health Block Grant, Title XIX (Medicaid), and the Social Services Block Grant of the Social Security Act. State governments and private entities also fund family planning programs. Sources of both for-profit, and not-for-profit private sector funds include direct patient fees, private contributions and insurance plans. Although most family planning services are provided by private physicians, public sector family planning programs serve an estimated 7.7 million women. Approximately 3.7 million of these women received services from Title X funded programs, including 3.1 million women from low-income families.

The federal government does not to include abortion as a method of family planning, and does not support abortion or abortion-related services as part of either domestic or international family planning programs. The government does advocate voluntary family planning as a means to reduce abortion, to improve maternal and child health and to enhance the ability of individuals to choose the number and spacing of their children.

The United States, through the U.S. Agency for International Development (AID), is the leading donor of international population assistance among all bilateral and multilateral donors. The United States has also been the leading country in contraceptive technology. Family planning programs are an essential element of the U.S. development assistance strategy. Since 1965, when the population assistance program was established, the United States has provided over $4 thousand-million for population activities in over 100 developing countries.

The objectives of U.S. population assistance are to: (1) enhance the freedom of individuals in developing countries to choose voluntarily the number and spacing of their children, (2) encourage a balance between population growth rates, economic productivity and available natural resources, and (3) improve the health and survival of mothers and children by promoting adequate birth intervals and childbearing during the safest years. The United States does not support programs in which there is any element of coercion of individuals to practice family planning or to accept any particular method of contraception. Since 1973 U.S. law has prohibited funding of abortion services abroad. In 1984 directives established under the so-called Mexico City Policy extended restrictions to prohibit funding to foreign non-governmental organizations that promote or support abortion services or counseling with private or public funds.

ENVIRONMENTAL STRESSES FROM POPULATION GROWTH AND RESOURCE CONSUMPTION

Environmental quality in the United States, as elsewhere, is influenced by population growth and distribution, resource consumption and the technologies used to sustain the standard of living. People use natural resources and generate wastes in the course of producing goods and services, and consuming them. Population growth and economic development are both also linked with degradation of air and water quality, and depletion of resources such as water, farmland, fossil fuels, open space and the plants and animals that inhabit them.

A nation's development and economic policies also are decisive factors influencing the relationship between population and the environment. In the United States for example, population shifts into urban and suburban areas and sensitive ecosystems have had adverse environmental impacts on the supply and quality of water and air, and on the availability of farmland and open space. Increases in investments in environmental protection have mitigated the full impacts that would otherwise have occurred with this population growth and commensurate increase in resource consumption. These investments have been funded by growth in the nation's economy. However, maintenance of a comfortable standard of living over the long-term is ever-more dependent on achieving a sustainable balance between population growth and available resources.

Urban and Rural Population Impacts on the Environment

U.S. environmental policy has often focused on controlling urban environmental impacts, such as water pollution from municipal sewage and industry, or air pollution from factories and automobiles. By effectively integrating environmental considerations into urban development decisions, certain types of pollution were greatly reduced while the U.S. population grew about 22 percent from 1970 to 1990.

For example, emissions of many key air pollutants fell. Between 1970 and 1989, lead emissions decreased 96 percent; emissions of total suspended particulates dropped 61 percent, sulfur oxides 26 percent, carbon monoxide 40 percent, and volatile organic compounds 31 percent.[15] Of the key pollutants only nitrogen oxides did not show improvement. (See Chapter 6.) These reductions occurred while the population, economy and the number of emissions sources were all growing.

Industrial discharges of some common water pollutants also decreased. Between the mid-1970s and mid-1980s, discharges by industry of total suspended solids (TSS) and biological oxygen demand (BOD), two traditional water pollution indicators, declined by 96 percent and 93 percent, respectively.[16] Municipal sewage treatment plant discharges and BOD decreased by an estimated 46 percent between 1972 and 1982.[17] There is also evidence of impressive water quality improvements in specific metropolitan watersheds such as the Delaware and Potomac Rivers and the Great Lakes.

In recent years there has been growing recognition of the significance of small sources of pollution in large and small population centers as well as rural areas. As larger industrial and municipal point sources have come under control, the relative contribution of "non-point" sources of water pollution has increased. For example, the states estimate that in 1990, more river miles were polluted by urban runoff including storm sewer flows than by industrial discharges.[18]

Water availability is an issue of growing importance in expanding metropolitan areas, especially in the arid Southwest, where meeting the needs of growing populations and agriculture is sometimes difficult. In addition, droughts in the 1980s and during the summer of 1990 have alerted residents in other parts of the country to problems of water scarcity.
Irrigation-dependent farming is also threatened in parts of the central United States where groundwater is being withdrawn for irrigation much faster than it is being replenished. Rapid population growth in areas with inadequate water supplies threatens not only the environment but also the viability of continued agricultural production in these regions. Farmworker exposure to pesticides appears to be a relatively high risk environmental health problem in the rural areas of the United States.[19] Pollutants in drinking water, particularly in small rural water systems, are also a growing national concern.

The U.S. Environmental Protection Agency and many state governments now believe that farming is responsible for significantly more river pollution than any other activity and is also a major cause of groundwater pollution.[20] Although intensive use of agricultural chemicals has increased agricultural output, residues of these chemicals have diminished the quality of some soils, and many of the nation's waters. Mining and timber harvesting also have harmed water quality in certain rural regions, particularly the Pacific Northwest and Appalachia. These rural industries and the growth of suburban areas have contributed to the destruction of forests, grasslands and wetland ecosystems. Coal-burning electric power plants, generally located in rural areas, have contributed to regional haze and acid deposition.

ENVIRONMENTAL CONSEQUENCES OF FUTURE POPULATION DISTRIBUTION

Population distribution in the United States will continue to shift over the next several decades. If the United States succeeds in cleaning up past mistakes and adopting a pollution prevention culture, the environmental impacts of these changes will be minimized. Nevertheless, regional population changes will undoubtedly stress the environment in ways that are difficult to predict or prevent.

Of particular concern in the United States is the effect of population shifts—from central cities into the suburbs, from the interior to the coastal areas, from the East to the South and West. Each of these trends has tended to increase transportation demands with commensurate increases in infrastructure, energy use and emissions, and to put more pressure on natural resources such as water supplies, river and estuary habitats, and open space in general. Encroaching urban growth also brings increases in disposable waste needs and greater problems in finding suitable disposal sites.

The U.S. population is projected to grow to 300 million by 2030—a 20-percent increase—and to begin to decline slowly thereafter. This growth will be distributed in new ways around the country. According to the U.S. Bureau of the Census, the most rapid growth between 1990 and 2030 is likely to occur in the Mountain States (118-percent growth or 18.5 million additional people) the Southeast (73 percent, almost 20 million additional people), the Southern Plains (Texas and Oklahoma up 67 percent with 14 million additional people), and the Pacific states (up 50 percent with nearly 18 million additional people).[21]

These growing regions may see reduced pollution from agriculture but a rapid increase in urban problems, especially from the growing number of non-point sources associated with urban development. Even if pollution controls are strengthened (as planned, for example, with regard to motor vehicles), an increase in the absolute number of urban sources of pollution because of population growth may result in an increase in overall pollution.

Another significant concern is protecting the recreational, commercial and ecological values of beaches, wetlands, estuaries and coastal waters. Population density in coastal counties is already more than four times the national average, and 17 million more people are predicted to live near the coasts by 2010. Oil pollution, closures of tainted shellfish beds, trash on beaches and the loss of wetlands all have increased public awareness of the dangers to coastal environments. Population growth in limited coastal spaces will result in increased congestion and increasing pressures on coastal water and air quality, wetlands and other habitats.

Water supply and allocation issues will continue to be a concern where rapid growth is projected in dry Southwestern regions. Unless cost-effective and environmentally sound solutions are found, water shortages may make these areas less attractive as centers of economic growth.

Another concern will be loss of farmland in or near growing metropolitan areas. This concern seems to be unwarranted either from the perspective of food security or from a purely economic point of view. USDA projections indicate that the United States will have adequate soil and water resources for food production over the next 50 years even if export demand is high and there are minimal increases in farm productivity.[22] Nevertheless, given the prominence of farming in the national heritage and the value that agricultural open space provides, many Americans are disturbed by the loss of prime farmland and rural landscapes near expanding metropolitan areas.

Several regions of the United States are expected to experience population *declines*, which could create different kinds of environmental problems. According to the U.S. Bureau of the Census, population in the Northeast is projected to decline 24 percent (13.3 million fewer people) between 1990 and 2030, while the Midwest population may decline 22 percent (8 million fewer people).[23] If these trends occur, urban development pressures will ease, but other problems such as poorly-maintained sewage treatment plants or other deteriorating infrastructure could accompany stagnant economies and an eroding tax-base.

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CHAPTER

2

HUMAN HEALTH AND THE ENVIRONMENT

Overview

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National Infrastructure for Environmental Health

■

Environmental Health Hazards

■

Special Populations

■

Exposure to Environmental Health Hazards

OVERVIEW

Federal, state and local government efforts to assure safe supplies of food and water, to manage sewage and municipal wastes, and to control or eliminate communicable illnesses have contributed substantially to human health improvements in the United States. The past 20 years mark a period of great expansion of knowledge about environmental threats to human health; major advances have also been made in the use of scientific methods to assess the significance of those threats. The most difficult challenges today come from uncertainties about the human health effects of our society's pervasive use of fossil fuels and synthetic organic chemicals, whose combustion or breakdown products are widespread, usually at low levels, in our air, water, food, workplaces and homes.

Another change in environmental health practice in recent years has been in the methods employed. Environmental health research and practice typically involve choosing ways to modify or otherwise control aspects of the indoor and outdoor environment that may cause severe disability or death to human populations. During the past two decades this process has become more formal and more quantitative, and is now generally referred to as *risk management*. The overall process involves two related activities that have become central to reaching sound decisions about the control of environmental health hazards: these are *risk assessment*—a scientific assessment of the scope and severity of potential risks to human health—and *risk management*—a comparative cost-benefit analysis of alternative strategies to reduce risk and determine relative effectiveness. Although this chapter does not describe specific risk assessments or risk management strategies, the general process is beginning to serve as the basis for decisions by U.S. government agencies responsible for protecting the public from environmental health hazards.

NATIONAL INFRASTRUCTURE FOR ENVIRONMENTAL HEALTH

The last two decades have been a period of transition in which some of the federal government's traditional responsibilities for environmental health activities have been shifted from the U.S. Public Health Service to the U.S. Environmental Protection Agency and other new agencies. The institutional challenge facing the government is to develop increased coordination and collaboration among the various participating agencies.[1]

At the national level, federal agencies play a large role in defining and pursuing environmental health goals through research, administration and service programs, as well as via regulation and enforcement activities. These agencies also provide valuable assistance and support to state environmental departments and health agencies.

State and local agencies must address many of the same environmental health issues as the federal government. The scope and responsibilities of state agencies are extremely diverse and vary from state to state. Environmental health programs at the state level may be administered by departments of environment, labor, health or some combination of these jurisdictions.

Non-government entities, including colleges and universities, address a range of environmental health research and policy issues. In addition, many environmental and professional organizations are active at the national level and also have state and local chapters. Success in pursuing their various interests depends largely on coordination with other participants in the system. The role of non-governmental entities in environmental health has

A FEDERAL NETWORK OF ENVIRONMENTAL HEALTH AGENCIES

Since 1970, in response to growing public awareness and concern over environmental threats to human health and environmental quality, the U.S. Congress has established a number of agencies to address different aspects of environmental health issues. This network of federal agencies, moreover, involves numerous constituent and participating groups, organizations, and entities with different interests from all levels of government.

The network includes the Environmental Protection Agency (EPA), a free-standing agency of the federal government, and the Occupational Safety and Health Administration (OSHA), which is part of the Department of Labor. It also includes seven different agencies within the Department of Health and Human Services: the Agency for Toxic Substances and Disease Registry (ATSDR), the National Center for Environmental Health and Injury Control (NCEHIC), the National Institute for Occupational Safety and Health (NIOSH), the National Center for Toxicological Research, the National Institute for Environmental Health Sciences (NIEHS), the National Toxicology Program, and the Public Health Service Committee to Coordinate Environmental Health and Related Policy.

become increasingly important over the past 20 years as more emphasis has been placed on public/private interaction.

Surveillance. Public health surveillance is the systematic collection, analysis, interpretation and dissemination of health information. Surveillance, and the data systems that support it, allow public health professionals to understand the health status of a population, to manage public health programs and to prevent adverse health events. Public health data collection programs, such as the National Health and Nutrition Examination Survey (NHANES) conducted by the U.S. Public Health Service, require collection of federal, state and local data.

Improvement of surveillance methods has been a major objective of environmental health agencies during the past 20 years. Surveillance not only establishes a baseline from which trends can be followed, but it also allows the timely detection of emerging health problems. The U.S. Standard Death Certificate has been modified to include more detail on diagnostic information and the usual job of the decedent. The National Death Index was developed to determine the vital statistics of persons identified through health studies or registries as having been exposed to environmental hazards. Screening programs, largely managed by local and state agencies, have been implemented to monitor populations for abnormal blood concentrations of various toxicants, or for health abnormalities indicating toxic exposures.

Existing survey systems have been used to obtain information on the distribution of health effects and of blood/urine concentrations of toxicants in the general population. Finally, geographic analyses of death certificate information have been used to identify high risk populations.

PARTICIPATORY GOVERNMENT

One notable instance of broad cooperation on environmental health in the United States has been the development of *Healthy People 2000: National Health Promotion and Disease Prevention Objectives*, a report published by the federal government in September 1990. *Healthy People 2000* is the product of a collaborative effort that began in 1987 and involved over 300 organizations, including professional societies, citizens groups and public agencies from every part of the country.

Healthy People 2000 establishes a national agenda for the next decade with measurable targets for improving health, reducing risk factors for disease and disability, and improving health service delivery. It sets forth 300 specific objectives in 22 priority areas, organized under the three main goals of health promotion, health protection and preventive services. Each priority area contains objectives for special populations. In addition, the report establishes a category for objectives related to surveillance and data systems, because maintaining the integrity of the national data collection effort at every level is essential to monitoring the nation's progress successfully.

ENVIRONMENTAL HEALTH HAZARDS

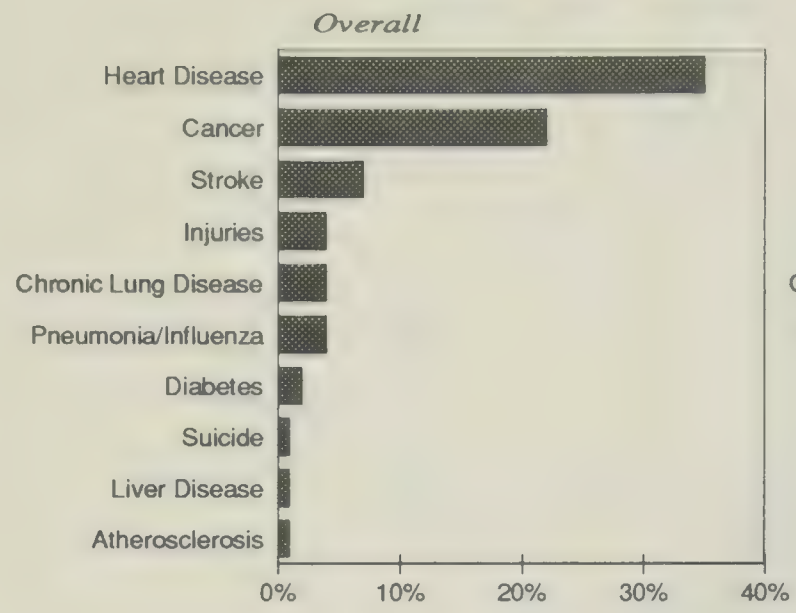
More than two million U.S. residents die each year from all causes. The chart in Exhibit 2.1 illustrates the 10 leading causes of death for 1988, with a breakdown of special populations for comparison. Although chronic diseases (heart disease, cancer and stroke) constitute the top three causes of death overall, followed by unintentional injuries and chronic lung disease, this figure also illustrates that the leading causes vary considerably in rank order among the several ethnic subpopulations in the United States. The use of death rates from various causes is common in the planning and evaluation of public health programs; another useful statistic is premature deaths, measured by the years of potential life lost before age 65. These different measurements for mortality can yield different rankings in the causes of death within the same subpopulations. For instance, heart disease is a leading cause of death among American Indians and Alaska Natives, but unintentional injuries are responsible for the most years of potential life lost by these same ethnic groups. (See Exhibit 2.2.)

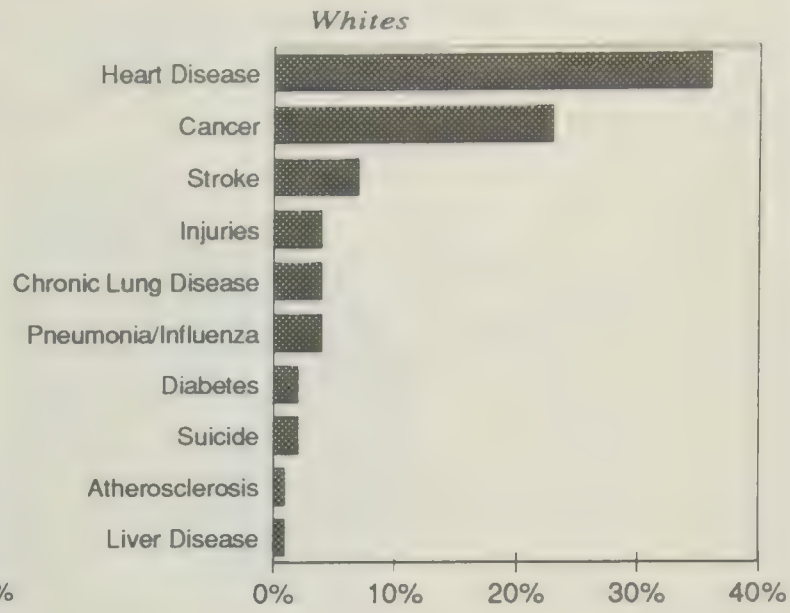
During the past 20 years, epidemiological research has allowed the United States to learn more about the risk factors associated with these causes of mortality. These are listed in Exhibit 2.3. Environmental health hazards, including naturally occurring and manmade contaminants found in residential, occupational and outdoor environments, contribute to some causes of mortality, including cancer and chronic lung disease.

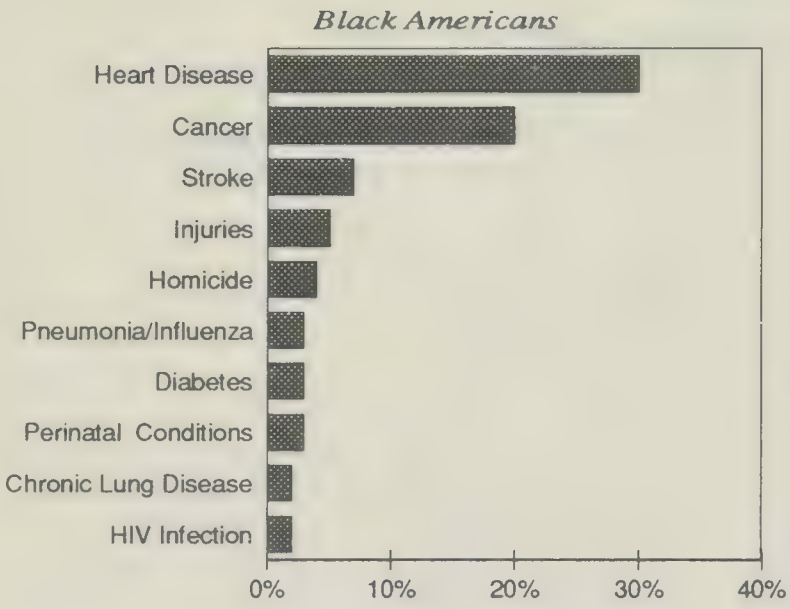
Morbidity

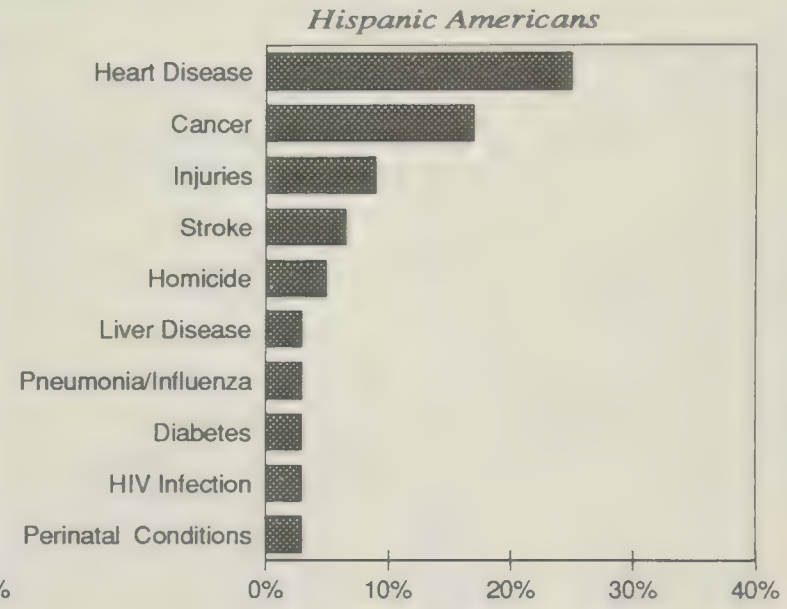
In addition to their association with selected causes of death, environmental health hazards have also been linked with a number of chronic and acute health conditions.[2] Among the specific conditions that have been associated with environmental hazards are certain respiratory conditions, including asthma, chronic bronchitis and emphysema, and tuberculosis. Other conditions include: infectious diarrhea, salmonellosis, listeriosis, campylobacteriosis, gastroenteric disease, urinary tract infections, certain skin disorders, hepatitis B, and certain cancers, including those of the breast, lung and liver.

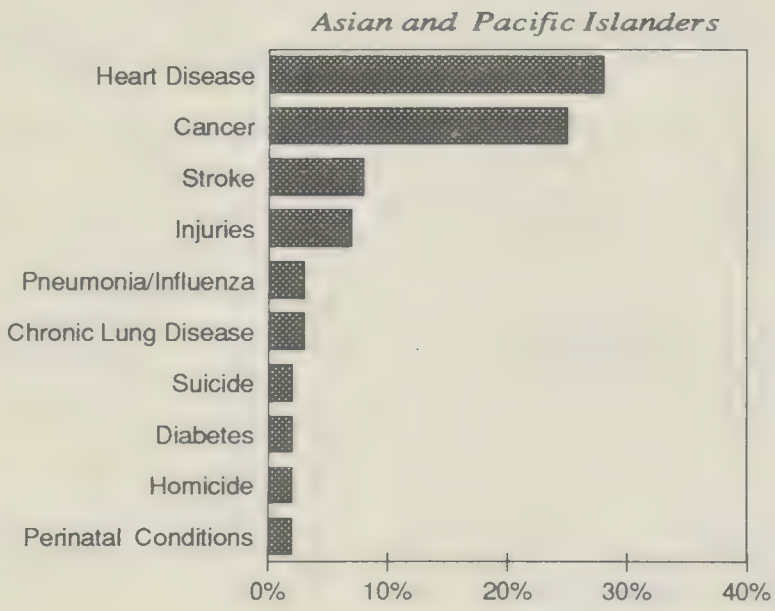
LEADING CAUSES OF DEATH

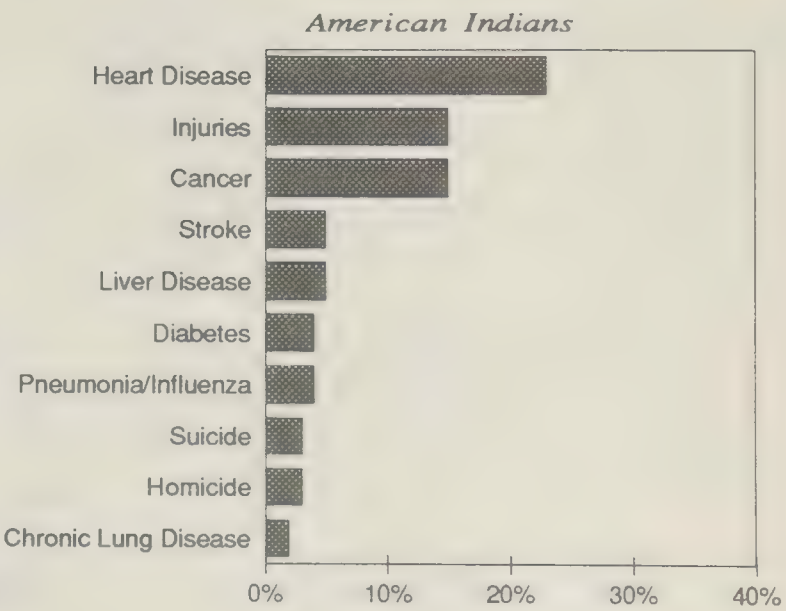






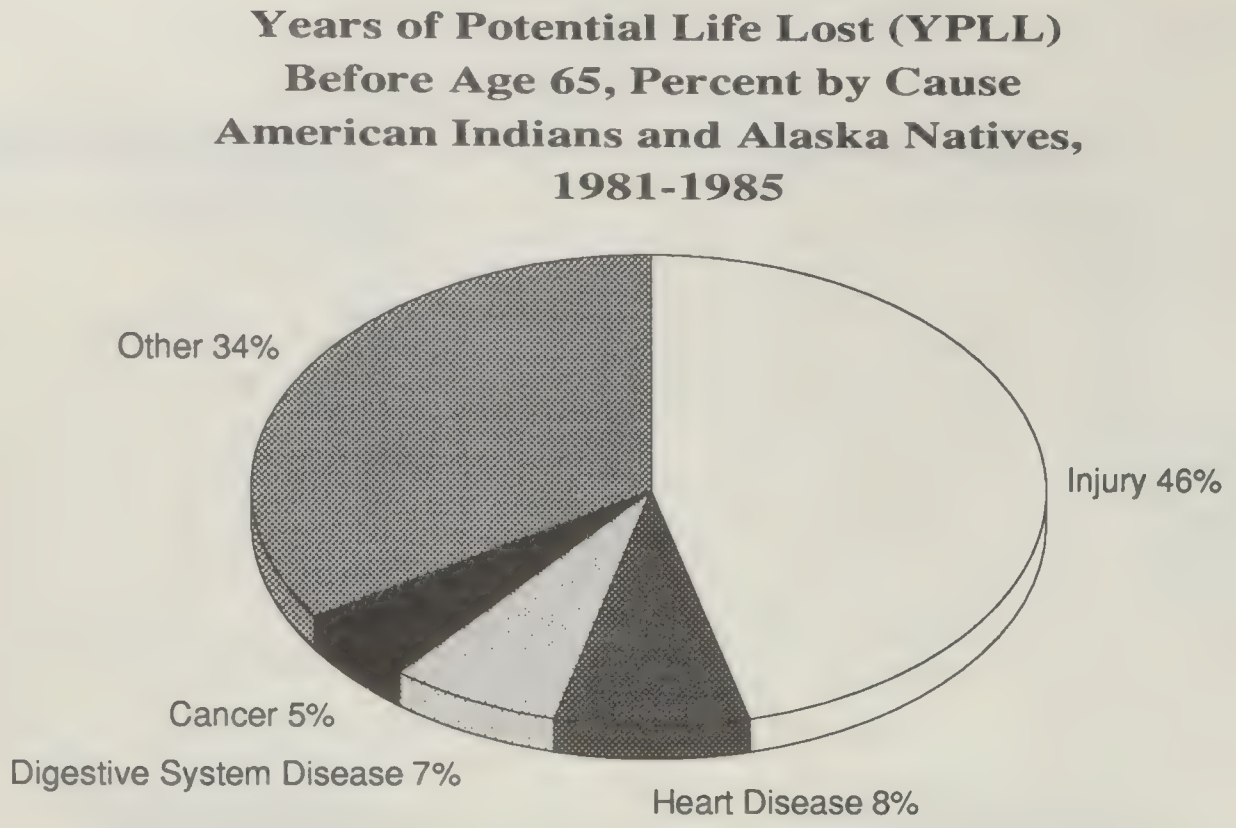






Source: *Health, United States* , 1990; for Hispanics - *Healthy People 2000* .

Exhibit 2.1



Source: U.S. Department of Health and Human Services, Public Health Service, Indian Health Service, *Trends in Indian Health 1990* (Washington, D.C.: U.S. Government Printing Office, 1990).

Exhibit 2.2

SPECIAL POPULATIONS

Continued progress in improving the health of U.S. residents will depend substantially on health improvements for particular populations that are at especially high risk of premature death. These population groups include people with low incomes and members of some racial and ethnic minority groups. These population groups are highlighted below, with information summarizing selected health problems associated with exposure to environmental hazards.

The first major federal effort to examine environmental health issues across minority populations was the 1990 "National Minority Health Conference: Focus on Environmental Contamination." That same year, the U.S. Environmental Protection Agency (EPA) established a Task Force on Environmental Equity to examine evidence that racial and low-income communities bear a high environmental risk burden and consider what EPA might do about any identified disparities. In addition, several national environmental organizations formed an Environmental Consortium for Minority Outreach. Both government and non-government entities are becoming more aware of the special environmental health problems of minorities. Following is a discussion of some of the health problems that are experienced disproportionately by these groups.

Black Americans

Black Americans have lower longevity than white Americans in several health categories. Black homicide rates in the United States have increased steadily since 1984. Homicide is a major contributor to the declining life expectancy among U.S. blacks, particularly males. In 1988, homicide continued to be the

RISK FACTORS FOR LEADING CAUSES OF DEATH

Heart Disease	Tobacco, High Blood Pressure, High Blood Cholesterol, Obesity, Sedentary Lifestyle
Cancer	Tobacco, Dietary Patterns, Alcohol, Occupational & Environmental Exposures
Stroke	Tobacco, High Blood Pressure, High Blood Cholesterol, Sedentary Lifestyle
Unintentional Injuries	Nonuse of Automobile Safety Belts, Alcohol, Home Hazards
Chronic Lung Disease	Tobacco, Occupational & Environmental Exposures

Source: U.S. Public Health Service.

Exhibit 2.3

leading cause of death for black males aged 25-44, with a rate that was seven times higher than for whites.[3]

Although the proportion of black Americans afflicted with asthma is only slightly higher than whites, blacks are hospitalized more frequently and die three times more frequently. The reasons for the difference in death rates are not clear, but may be related to differences both in levels of health care and in exposure to environmental factors such as air pollution.

Lead poisoning, which is further discussed below, is a major concern. A 1988 report by the U.S. Agency for Toxic Substances and Disease Registry estimated that among the approximately 350,000 inner-city black children aged six months to five years who live in families with incomes of less than $6,000, more than two-thirds have blood levels of lead over 15ug/dl and more than 10 percent have levels above 25 ug/dl.[4] Studies indicate that diminished mental development, and decreased gestational age and birthweight are all associated with blood lead levels over 10 to 15ug/dl in children, and that reductions in gestational age and birth weight are associated with fetal exposure levels of lead of less than 15ug/dl.[5]

Hispanic Americans

As with black Americans, Hispanic Americans have a higher burden of illness. Unintentional injuries, for instance, are the leading cause of death for Hispanic Americans through age 44, and homicide is a significant cause. In 1988, homicide rates among Hispanics were three to four times the rate of whites among males aged 15-44.[6]

Migrant and seasonal farmworkers, who are largely Hispanic, are another special population subgroup. Their infant mortality rates are 25 percent greater than the national average; life expectancy is 49 years, compared to 75 nationally; and rates of parasitic infection among some farmworkers approaches 50 times the national average.[7] Environmental hazards for farmworkers include substandard, dangerous or nonexistent housing, lack of potable water, rodent infestations and absence of proper

NATIONAL MINORITY HEALTH CONFERENCE

The Agency for Toxic Substances and Disease Registry (ATSDR) established a Minority Environmental Health Program Initiative that specifically addresses issues involving hazardous waste. Under this initiative, ATSDR and the U.S. Environmental Protection Agency sponsored the first National Minority Health Conference in December 1990 in Atlanta, Georgia. The purpose of the conference was to advance scientific knowledge of minority health issues associated with exposure to hazardous substances, and to determine the research and information needs of environmental health professionals.

Conference participants identified priority issues for health professionals to address when working with minority communities. Key action items included lead abatement procedures and the need to involve the public in addressing environmental health issues, particularly the health concerns of minorities living and working near hazardous waste sites. Additional parts of the Minority Environmental Health Initiative are integral to ATSDR's programs, particularly demographic analysis and health communications.

waste disposal. Working conditions include pesticide exposures, absence of drinking water and toilet facilities, and long hours of stooping and lifting under the sun. This population suffers from a high incidence of infectious diseases, diarrhea, urinary tract infections, skin disorders and tuberculosis. Small children and pregnant women within the migrant farmworker population also have significant health problems.

Asian Americans/ Pacific Islanders

Asian Americans and Pacific Islanders are the fastest growing U.S. minority group. About three-fourths are recent immigrants. Tuberculosis, hepatitis B and liver cancer occur among Southeast Asian immigrants at rates far above U.S. norms, and the lung cancer rate for Southeast Asian men is 18 percent higher than the U.S. average. The breast cancer incidence rate for native Hawaiian women is 29 percent higher than among whites.

Environmental causes of excess mortality in this group may be related to exposure to environmental toxicants. Examples include pesticide and herbicide contamination, which increasingly affect water supplies and food chains. As population densities increase on Pacific islands, entire ecosystems are at risk. These problems disproportionately affect those living in poverty.

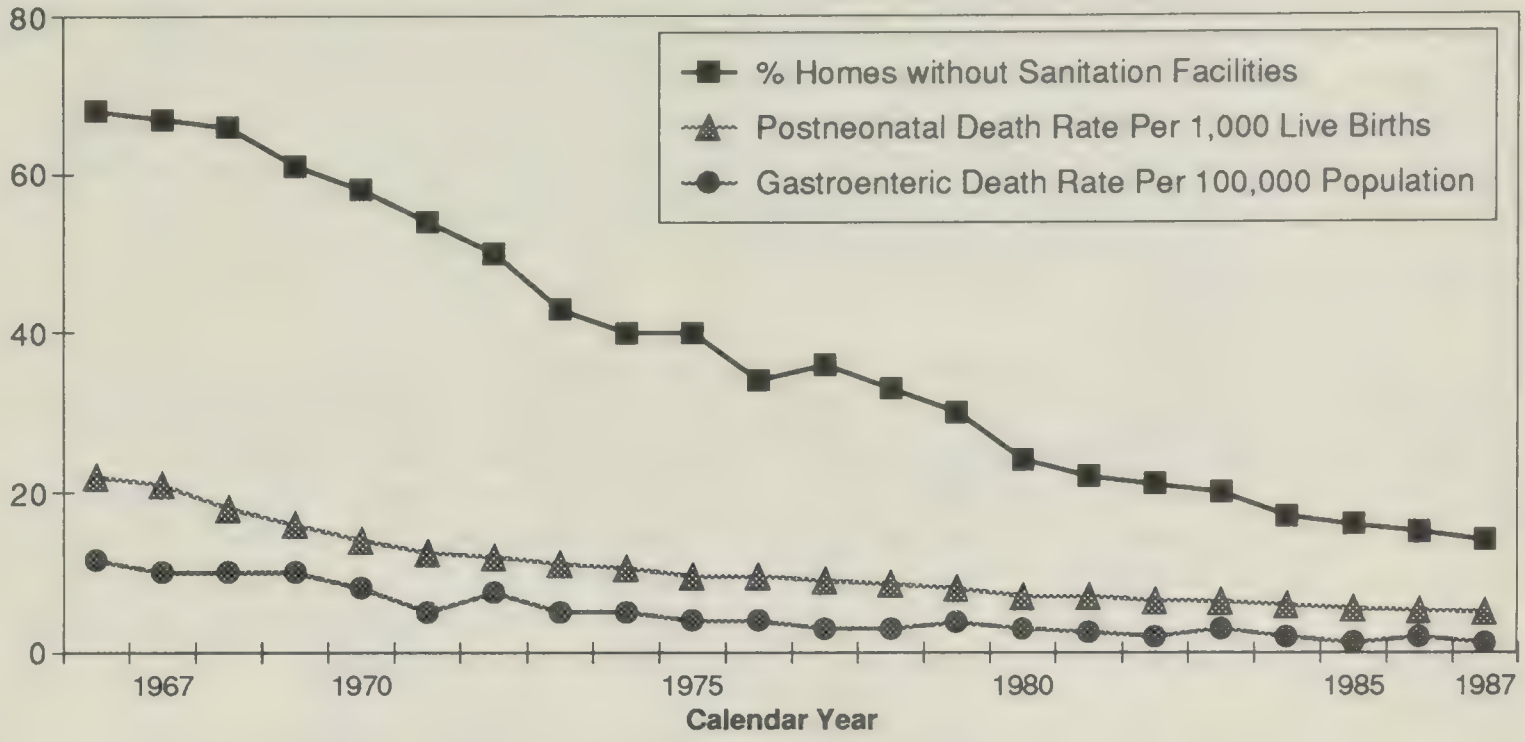
American Indians and Alaska Natives

Public health experts have long understood that inadequate sanitation is a cause of gastroenteric disease and death. The Indian Health Service of the U.S. Public Health Service has demonstrated that basic improvements in home and community environments can lead to significant reductions in mortality among American Indians and Alaska Natives. These improvements have included construction of drinking water systems and sewage and solid waste collection and disposal systems for American Indian and Alaska Native communities in which environmentally related disease and death rates previously ranged from three to more than seven times the overall U.S. rates. After funds were provided to construct the systems and the percentage of homes without sanitation facilities diminished, the rates of environmentally related disease and death were reduced.[8]

Exhibit 2.4 shows the decline in death rates as more American Indian homes were served by adequate sanitation facilities. Although a direct cause-and-effect relationship has not been scientifically established between these

two events, the availability of sanitation facilities and improved housing are together widely credited with contributing to the remarkable improvements in the health status of American Indians and Alaska Natives during the last two decades.

Gastroenteric and Postneonatal Death Rates Versus Lack of Sanitation Facilities for American Indians and Alaska Natives



Source: U.S. Department of Health and Human Services, Public Health Service, Indian Health Service, *Trends in Indian Helath 1990* (Washington, D.C.: U.S. Government Printing Office, 1990).

Exhibit 2.4

EXPOSURE TO ENVIRONMENTAL HEALTH HAZARDS

Although much has been learned over the past 20 years about environmental threats to human health, the scientific basis for hazard-specific risk management is still in the early stages of development. Measures to diminish exposures to contaminated food and water, to clean up contamination of land and to control communicable illnesses have contributed substantially to health improvements in the United States. But the most difficult challenges for environmental health today come from what is not known about the toxic effects of the use of fossil fuels and synthetic chemicals. Only a small percentage of thousands of commonly used chemicals have been adequately tested for their ability to cause adverse health effects, including their effects on the human neurologic, immunologic and reproductive systems. Another challenge today is the effect of increased population density on the mental and physical health of Americans and its relationship to violent and abusive behavior. The following discussion regarding what is known about potential environmental health hazards is only representative of the many pressing issues confronting health professionals in the United States.

Air

Diseases believed to stem largely from air pollution include chronic bronchitis and emphysema, lung cancer and asthma. All of these diseases have

increased in the United States over the past 20 years. Data from the National Center for Health Statistics demonstrates a particularly disturbing increase in asthma prevalence, rates of hospitalization and mortality over the past decade. The United States has undertaken numerous epidemiologic studies to explore the relationships between these respiratory diseases and indoor and outdoor pollution. In general, outdoor air pollution has decreased while indoor air pollution has increased over the last two decades.

Indoor Air Pollution. In the 1970s, following the OPEC oil embargo, energy conservation programs were encouraged throughout the United States. New buildings were constructed with designs that helped to conserve fossil fuels. Ventilation rates were reduced and structures were sealed to reduce infiltration of outside air. An unintended result was increased indoor air pollution.[9] There are a variety of indoor air pollution sources, including environmental tobacco smoke, radon, chemical releases from carpets and paints, and emissions of volatile organic compounds from office and mechanical equipment. Some or all of these may exacerbate respiratory diseases.

Outdoor Air Pollution. Measured decreases in atmospheric levels of particulates and sulfur dioxide over the past 10 to 30 years indicate that progress has been achieved in reducing major outdoor pollutants. Nevertheless problems remain, particularly with regard to urban smog (ozone). Ozone has been shown to exacerbate asthma, causing increased use of emergency-room services.[10] Past episodes of severe air pollution in the United States provide evidence that persons with pre-existing respiratory conditions are particularly vulnerable to poor air quality.[11]

Food

Food is subject to natural and manmade contamination from insects, pathogenic bacteria, pesticides and toxic metals. Food may also contain numerous additives, some of which have been found to be unsafe for human consumption. Public interest in a safe and healthy food supply has grown during the last 20 years. In general, chemical contamination of food (e.g. pesticides and additives) has declined over the last two decades and microbial-borne contamination of food has increased as agricultural productivity has increased. Despite isolated instances of food-borne hazards, the nation's food supply remains one of the safest in the world.

Pesticides and Additives. The American public is exposed to pesticides and various food additives every day. Both assist in ensuring an ample, high-quality food supply. Pesticides reduce crop losses to insects and plant diseases; food additives help to provide American consumers with a varied food supply that is nutritious and safe. Food product testing by the Food and Drug Administration (FDA) for more than 30 years has demonstrated that between 96 and 98 percent of foods tested for pesticide residues are consistently within legally established levels (tolerances as established by the EPA), and contain no pesticides prohibited for use on food.

Food safety issues have also been addressed through cooperative efforts between the FDA and the food industry. One such example is the limitation of lead ingestion achieved through the use of non-lead solders for cans and the use of non-leaded glazes on ceramicware. A direct result of the cooperative effort has been the reduction of the contribution of food to children's average blood lead levels from about three ug/dl in 1978 to less than 0.5 ug/dl in 1991.[12] The potential environmental impacts of food safety issues are also addressed by the FDA through the environmental review procedures of the National Environmental Policy Act.

Microbial Contamination. Microorganisms are naturally present in soil, water and air, and consequently they are always found in plants and animals used for food. From the field or boat to the table, each processing or preparation step potentially subjects food to additional opportunities for contamination. The Hazard Analysis and Critical Control Points (HACCP) process is used to identify critical points throughout the food production and distribution system where appropriate control can reduce or eliminate potential risks. In 1985 the United States experienced both the largest and deadliest microbial food-borne outbreaks ever recorded. Milk contaminated with *Salmonella typhimurium* was found to be responsible for over 16,000 cases of salmonellosis, and *Listeria monocytogenes* in imported soft cheese was responsible for 142 reported cases of illness and 47 deaths. The cause of these outbreaks was eventually traced to violations of public health regulations. In the salmonellosis outbreak, it was postulated that unpasteurized milk was allowed to reinfect pasteurized milk through the improper use of a valve on the pasteurizing unit. The listeriosis outbreak was due to the intentional mixing of unpasteurized milk with properly pasteurized milk, with the thought that it would impart a better taste to the final cheese product.

Salmonellosis cases continue to rise in the United States despite the many food-safety regulations in effect, and listeriosis cases remain at a constant 1600 to 1800 cases per year in the United States despite federal surveillance of the food supply, implying that foods responsible for causing listeriosis have not all been identified. Retail food operations are responsible for many outbreaks of gastroenteritis reported to the U.S. Centers for Disease Control. This is due to mishandling of the food, temperature abuse, cross-contamination during food preparation or inadequate cooking. These outbreaks can be minimized by adoption and enforcement of adequate food safety regulations.

Outbreaks of *Salmonella enteritidis* Infections in the United States, 1985 - 1990

Year	Outbreaks Number	Associated Cases	Deaths	Mean Cases Per Outbreak
1985	19	608	1	32
1986	34	1,042	6	31
1987	50	2,370	15	47
1988	37	956	8	26
1989	77	2,394	14	31
1990	67	1,785	3	27

Figures for 1991 are not yet complete. Data already received demonstrates that *S. enteritidis* has now surpassed *S. typhimurium* as being the most frequently isolated serotype of *Salmonella* isolated in the United States.

Source: Centers for Disease Control, Division of Infectious Diseases, The Enteric Disease Branch.

Exhibit 2.5

Epidemiological linkage to an observed increase in cases of *Salmonella enteritidis* implicated eggs as one of the major food vectors responsible for recent disease outbreaks in the United States and other countries. To reduce the incidence of salmonella enteritidis caused by eggs, federal regulations require that eggs not be pooled in large quantities prior to cooking, that they be refrigerated before cooking, that they be kept at a temperature which will not support growth after thorough cooking, and that pasteurized eggs be substituted for whole eggs whenever possible.

Individual households are responsible for many of the sporadic cases of salmonellosis, campylobacteriosis and listeriosis, due to mishandling of the food after cooking or not thoroughly cooking the food prior to consumption.

Educational materials to increase consumer awareness of methods to prevent food-borne diseases through proper sanitation have been developed and distributed by both public and private organizations at the national, state and local levels. Unfortunately, more consumer education is essential: investigations of food-borne diseases have indicated that many consumers remain unaware of the hazards and do not always take the necessary precautions to reduce their risks.

In addition to improving consumer education, other strategies are also needed. Farm management techniques strategies to reduce colonization of farm animals by these human pathogens are being explored. Sanitary shipping, slaughter and processing operations are also vital to reducing cross-contamination. Chemical, physical and biological methods that would indicate microbial growth and/or time and temperature abuse are being evaluated. These indicator methods would alert food handlers when incorrect handling has occurred at any stage of food processing. Methods that reduce the incidence of key pathogens may also reduce food-borne illnesses caused by certain other bacterial, viral and parasitic pathogens.

Water

Contaminated surface water and groundwater can adversely affect human health through either direct or indirect exposure to infectious or toxic agents. Direct exposure to these agents can occur when a contaminated water supply is used for drinking, cooking, bathing, swimming, or washing utensils used for cooking or eating. Water can indirectly affect health when people consume crops irrigated with contaminated water, livestock or wildlife that used a contaminated water supply, or fish, shellfish or aquatic plants that have grown in contaminated water. Water is also a habitat for vectors of disease (e.g. mosquitoes). Even if a water supply is safe or has been adequately treated, it can be contaminated by infectious and toxic agents as it is distributed to the user. This can happen when these agents are reintroduced into plumbing or distribution systems by cross-connections with sewage lines or infiltration through breaks in waterlines, or through leaching of toxic substances from the plumbing system.

Drinking Water. Waterborne cholera and typhoid fever have virtually been eliminated in the United States. Between 1971 and 1988, a total of 564 documented waterborne disease outbreaks of all types (or an average of 31 outbreaks per year) affecting approximately 138,000 people (or approximately 7,700 people per year) were reported in the United States based on voluntary reporting of information. The most frequent conditions that resulted from this contamination were gastroenteritis and giardiasis.

Although the most severe public health effects from contaminated water—such as cholera and typhoid—have nearly been eliminated by chlorination and filtration, hazards still remain in the nation's drinking water supply. Contaminants of increasing interest over the last 20 years have been radionuclides, lead, chlorine-resistant microbiological contaminants, pesticides and toxic chemicals, and disinfection by-products. Improvements in technology have allowed the detection of a greater array of contaminants, and their detection at lower levels. This has resulted in concerns about the extent of exposure and associated health effects, including the combined effects of exposure to contaminants. Increased knowledge of health effects will continue to aid in the development of additional federal drinking water standards.

The Safe Drinking Water Act of 1974 was enacted to assure that public water supply systems meet minimum national standards for the protection of public health. The act requires the regulation of contaminants that may have an adverse effect on human health, and that are known or anticipated to occur in sources of drinking water. The effort to increase the proportion of people

who receive a safe supply of drinking water continues to be a focus of federal public health and environmental programs.

Risk assessments for chemical contaminants in drinking water are derived primarily from toxicological data based on laboratory animal observations, while risk assessments for pathogens have been derived from human and laboratory experiments. An additional source of data consists of national registries of individuals exposed to toxic substances such as trichloroethylene and benzene in drinking water. These registries, developed in the late 1980s, have the potential to provide additional toxicological information on long-term human health effects of the ingestion of contaminated water.

Contaminated Surface Water. Contaminated suface water has also been an important cause of adverse health effects. Federal and state programs originally focused on "point" sources of pollution such as industrial discharges that directly contaminate surface water. Now that some of the worst "point" source pollutants are federally regulated, "non-point" sources of water contamination have become the largest remaining sources of water pollution, contributing approximately 65 percent of the contamination in impaired rivers, 76 percent in impaired lakes and 45 percent in impaired estuaries of those waterbodies that were assessed by the states in 1985-86.[13] Primary non-point sources of contamination include: polluted runoff from farming, urban areas, mining, forestry, and building and highway construction. Runoff may carry oil and gasoline, agricultural pesticides, herbicides and fungicides, heavy metals and other toxic substances, as well as bacteria, viruses, silt, nutrients and oxygen-depleting compounds. The health effects that result from this contamination are varied, numerous and may be indirect. Individuals, for example, can be exposed to toxic chemicals when they consume fish and shellfish that are caught in contaminated water. Drinking water treatment plants may also get water supplies from contaminated waters.

Between 1971 and 1985, 24 percent of investigated national waterborne health problems were attributed to bacteria or viruses from untreated or inadequately disinfected and/or filtered wastewater.[14] Toxicants have also been found to escape treatment by some municipal wastewater treatment plants that are not designed to deal with them. For example, in 1986, the government estimated that 37 percent of the toxic industrial compounds entering surface waters from point sources were coming through such municipal wastewater treatment plants. These compounds included such toxic substances as cyanide, cadmium, chromium, zinc and other heavy metals.

Land

Health and environmental threats from the open waste dumps commonly used for solid waste disposal until the 1970s resulted in the establishment of managed "sanitary" landfills. Rainwater seeping through the waste can form leachate that percolates down through the soil and contaminates the groundwater. In the 1980s, with improved ability to detect toxics in groundwater and soils resulting from landfills, more advanced methods evolved to protect the public from exposure to contaminants emanating from these waste sites.

Abandoned Solid and Hazardous Waste Sites. Federal and state health assessments of such sites provide information about the toxicity of substances at these sites, pathways of human exposure and specific populations at risk for exposure. In the last 10 years, the federal government has conducted 1,325 of these assessments at sites in all 50 states.[15] The principal follow-up

actions include provision of alternate water supplies, restriction of site access, further environmental sampling, cleanup or removal actions, and referrals for health evaluations. (For more information, see Chapter 6.)

Sewage Sludge. Use of sewage sludge has been another controversial issue. In general, through improved management and appropriate use of sludge and its by-products, human exposure to toxins in sludge apppears to have diminished over the past two decades. Thousands of municipalities are currently recycling their sewage sludge. Both agricultural and non-agricultural sites benefit from the use of sewage sludge, which typically contains $50 to $60 of nutrients and soil-conditioning value per dry ton. Sewage sludge has been successfully used in the production of many different food, feed and horticultural crops, in sod production and turf maintenance, and in the management of forest production, as well as in reclaiming and revegetating areas disturbed by mining, construction and waste-disposal activities.

Workplace

Approximately 110 million people make up the U.S. work force, with most spending the major portion of their day in their work environments. Premature death, diseases, injuries and other unhealthful conditions resulting from occupational exposures to environmental health hazards continue to be important national problems. Although the number of fatal occupational injuries has gradually declined in recent years, nonfatal injuries and work-related illnesses appear to be increasing in absolute numbers. The increase, which is primarily in the trade and service industries, may be partly explained by growth in the work force and improved record-keeping.[16]

Improved technologies pose their own occupational risks. New chemical compounds continue to be introduced to the workplace environment at a rapid rate. Automation and robotics have demonstrated the potential for increasing cumulative trauma disorders, and the computerized office may well produce significant levels of stress. Stress has been well-documented in recent years as a cause of illness and behaviors such as substance abuse, tardiness and absence from work. Agricultural work continues to be one of the most hazardous occupations, with death and permanent disability rates that remain consistently high. Agricultural workers in the United States (3,169,000 full-time employees in 1988) face elevated risk of death or severe injury, lung disorders, dermatological conditions and other health effects while at work.[17] In addition, employees of small businesses, who make up the majority of America's workers, often do not have the benefit of safety and health measures tailored to their working conditions.

Occupational Fatalities. Occupational injuries cause a major portion of unintentional injury deaths, which are the nation's leading cause of lost productive years of employment. Estimates of combined and specific industry deaths vary widely, with totals for 1987 ranging from 3,400 to 11,000.[18] At least two major surveys suggest a 20- to 25-percent decline in industry deaths from 1978 to 1987.[19]

Fatalities from mining (including quarrying and extraction of oil and gas) fell somewhat during the mid-1980s, but still remain among the highest levels of occupational deaths, 31.9 per 100,000.[20] Agricultural worker deaths may be underestimated because many farm work forces have fewer than 11 workers and are therefore not identified by national data systems. The National Safety Council has estimated a rate as high as 52.1 deaths per 100,000 agricultural workers.[21] The safety record of manufacturers (4.3 deaths per 100,000 employees) was better than the average for all private industry (5.9 deaths per 100,000 employees) if only fatalities are considered.

When all job-related injuries are taken into account, however, accident prevention by manufacturers was below the average for all occupational categories.

Nonfatal Injuries. Nonfatal injuries that occur on the job may not only require immediate medical care, but may also involve extensive recuperation and permanent disability. The U.S. Department of Health and Human Services' National Institute for Occupational Safety and Health (NIOSH) estimates that at least 10 million injuries occur on the job in the United States each year, about 3 million of which are severe. Every workday more than 10,000 people in the United States suffer work-related injuries that result in lost work time. Almost one-half of all occupational injuries reported in 1989 by the U.S. Department of Labor's Bureau of Labor Statistics, required either time off from work or restricted job activity. Musculoskeletal injuries are the leading cause of disability of people in their working years, afflicting 19 million persons. Nearly one-half of the nation's work force are injured at some time during their working lives. The rate of nonfatal injuries appeared to be decreasing from the late 1970s to the middle 1980s. Beginning in 1978, the rate of these injuries declined for every year until 1984. Despite the number of occupational injuries, effective prevention is practiced in many workplaces, and approximately 48 percent of all places of employment report no injuries in a given year. As with other occupational health hazards, the prevention of severe trauma rests on the basic principles of control technology: engineering controls, work practices, personal protective equipment and monitoring of the workplace for emerging hazards.

Work-related Diseases. Work-related diseases, conditions and disorders have equally adverse health outcomes. Occupational lung diseases, cancers, cardiovascular diseases, disorders of reproduction, neurotoxic disorders, dermatological conditions and psychological disorders all exact a considerable toll on working Americans. In 1986, it was estimated that each year approximately 400,000 workers become ill from exposure to hazardous substances in the workplace and about 100,000 die prematurely from these exposures. Strategies developed in 1986 and 1988 for preventing these disorders recognized that some of these diseases, such as lung disease and cancer, can have a latency period as long as 30 years.

Lead is a hazardous substance that has been the subject of considerable recent concern to health professionals and the public. Workers exposed to lead include battery makers, construction workers, radiator repair workers, ceramists, rubber and chemical workers, enamel workers, insecticide workers and plumbers. Exposure to lead can produce a variety of cardiovascular, reproductive, neurotoxic, metabolic and hematologic effects. Peripheral and central nervous system effects occur in severe lead poisoning. Peripheral neuropathy of lead poisoning involves considerable loss of motor function. Acute encephalopathy may follow ingestion or inhalation of large amounts of lead, and may develop quickly to seizures, coma and death from cardiorespiratory arrest. There may be a progressive and irreversible loss of kidney function. In addition to the direct danger to the health of the worker, children and other family members can be exposed to lead dust transported into homes on workers' clothing. Children have developed renal dwarfism, hypertension, marked retention of urea and low urinary concentration.[22]

During the past 20 years, a greater number of women have been entering the work force. Consequently, health professionals have been shifting attention toward work force hazards that may especially affect the health of female workers. Women represent large numbers in certain textile industries, the jewelry industry and some other occupations, where they may

Occupational Health Hazards Affecting Women

Exposure to environmental hazards in the workplace raises some specific concerns for women related to reproduction and nursing. In the semiconductor manufacturing industry, for example, there are many situations in which women workers can be exposed to hazardous agents. For this reason, the National Institute of Environmental Health Sciences (NIEHS) is supporting a research project to investigate whether certain chemical, physical or ergonomic exposures in silicon wafer manufacturing are associated with an increased risk of spontaneous abortion or other reproductive problems such as birth defects. Another hazardous exposure can occur if workers inhale gallium arsenide just after the wafer baking process or during cleaning of the wafers. Other chemical agents such as chlorofluorocarbons used in the cleaning and drying of the wafers are also of concern. NIEHS will analyze personal interviews, daily diaries covering menstrual cycles and daily habits, and hormone assay data to determine if certain work behaviors or exposures place women in the seminconductor manufacturing process at risk for early pregnancy loss.

Another example of occupational health research on environmental hazards for women involves levels of human exposure to pesticides in developing countries. These levels are generally higher than in the United States because of differences in use patterns and availability of products that have been banned by the U.S. government. These raise distinct problems for women because many pesticides concentrate in breast milk. An epidemiologic study being conducted by NIEHS on a population of women in Mexico that has been exposed to DDT through farming activities has found high levels of metabolites of DDT in their breast milk. This exposure can lead to lactation failure in the mothers and toxic effects in their children.

be regularly exposed to hazardous chemicals, such as formaldehyde, dust, dyes, polishing agents, cleaning fluids and equipment that contribute to cancers and respiratory diseases. Toxic substances can affect a fetus directly, through exposures of the mother, and indirectly, by altering maternal and paternal germ-cell chromosomes. The National Institute of Health is currently conducting research to study these unhealthy conditions to better assist women and their offspring. These studies also benefit individuals at home and in developing countries. The trend toward more women in the workplace offers new challenges for continued improvement in the work environment as a result of improved risk assessment, management and communication.

Community

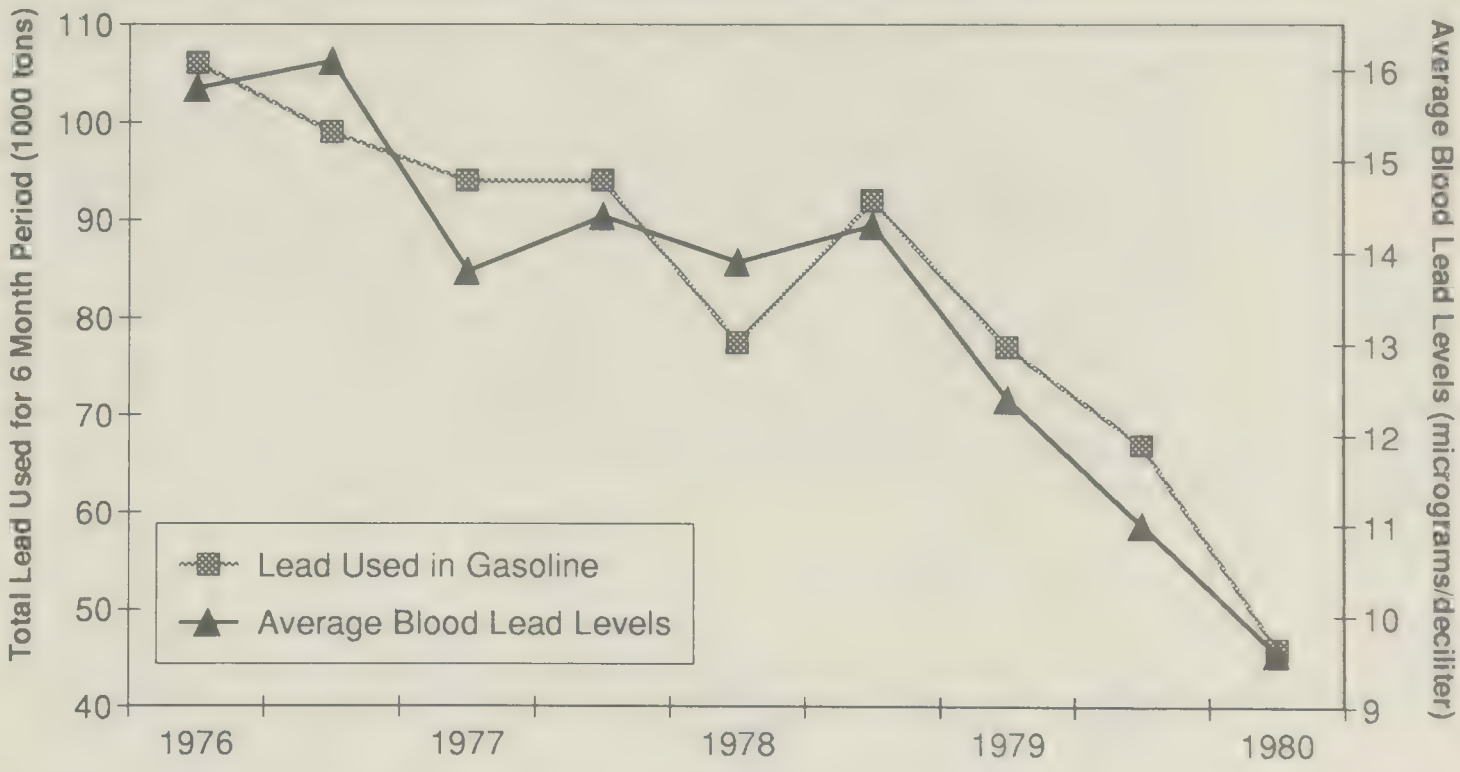
While the workplace affects a part of the population, the home and neighborhood affects the entire population. This section looks at the living environment as it relates to the health of the population, in terms of the condition of its housing and patterns of group infection from communicable diseases.

Housing. Alarm over lead poisoning has shifted from outdoor air sources to lead in homes and the surrounding soil. In the early 1970s, automobiles that burned leaded gasoline were the most important single source of airborne lead in the United States. The U.S. phased reduction in the allowable lead content of gasoline in the mid-1970s has substantially reduced exposure to airborne lead. Today the mean level of lead in human blood in the United States is about one-third that of the 1976 level.[23]

However, lead poisoning remains the most common and most socially devastating environmental disease of young children.[24] Lead is a common metal found throughout the environment in lead-based paint, air, soil, household dust, food, certain types of pottery, porcelain, pewter and water. The sources of lead that pose the most significant risk to human health, in descending order, are lead-based paint, soil and household dust, and drinking water. Early state and municipal actions intended to reduce exposure to leaded paint were largely ineffective. Effective action began in 1977 when the Consumer Product Safety Commission reduced the legally allowed level of lead in paints, permitting officials to concentrate on lead screening and abatement in pre-1977 structures.

A national approach to the largely preventable problem of lead poisoning from leaded paint has generated significant new knowledge of the serious health effects. Recent studies show that the effects of even moderate amounts of lead are more pervasive and long-lasting than previously thought; relatively low levels of lead (10-15 ug/dl) in blood causes diminished intelligence and neurobehavioral function; and millions of U.S. children have blood lead levels in the moderate range.[25] In 1991, the United States announced a national strategy to eliminate lead poisoning. Actions deemed essential over the next 20 years include increased support of programs that prevent childhood lead poisoning; increased abatement of lead-based paint and paint-contaminated dust in housing; reductions in other sources and pathways of lead exposure in children; and national surveillance for children with elevated levels of lead in their blood. (See Exhibit 2.6.)

Lead Used in Gasoline Production and Average NHANES* II Blood Lead Levels
(February 1976 - February 1980)



*National Health and Nutrition Examination Survey.
Source: J.L. Annest, "Trends in the Blood Lead Levels of the U.S. Population," in M. Rutter and R.R. Jones, editors, *Lead Versus Health* (New York: John Wiley and Sons, 1983) p.52.

Exhibit 2.6

Household Waste. Household waste is another environmental health concern. When disposed of improperly, common household waste can contribute to health problems including noxious smoke from burning trash, contaminated surface and groundwater, release of toxic wastes, and the creation of breeding ground for rats, flies and mosquitoes. Even when properly disposed of, household waste can contribute to air and water contamination when toxic substances such as pesticides, paints or solvents are disposed of with other household trash. Rain water seeping through buried wastes can form leachates that percolate down through the soil and contaminate groundwater. Other organic wastes, such as garbage and paper products, can decompose and form methane and other noxious gases.

Communicable Diseases. Most major childhood diseases are contagious. They can spread rapidly from child to child. Vaccines are some of the most important tools available for the prevention of childhood disease. If a significantly high proportion of individuals are immunized, transmission may be interrupted in the community, thus providing protection to those who are not themselves immunized. This indirect protection is called "herd immunity." The development and widespread use of vaccines for the prevention of infectious diseases has resulted in dramatic improvements in this nation's health status. Before 1960, children frequently became ill and sometimes died from communicable diseases such as measles, pertussis, polio and diptheria. Today, all 50 states now have school entry laws and most require immunization for attendance at preschool and day care centers. This has resulted in 98 percent of the children entering school being immunized against seven vaccine-preventable diseases.[26] Poliomyelitis, neonatal tetanus, congenital rubella and diphtheria have also been successfully controlled in the United States through the use of vaccines.

Vaccine technology has advanced considerably during the last 20 years, making many additional diseases potential targets for vaccine prevention. During the last decade, two new vaccines have been licensed (recombinant hepatitis B and Hemophilus influenza type B conjugate vaccines). In this brief period, these two vaccines, which represent formidable tools in expanding disease prevention for invasive hemophilus disease and hepatitis B, have gone from the laboratory to safe and effective products available to the public. Two multi-component vaccines have also become available: diphtheria-tetanus-pertussis and measles-mumps-rubella. Some segments of the U.S. population, however, remain unprotected from vaccine-preventable diseases. The current epidemic of measles in unvaccinated children indicates inadequacies in the nation's current capacity for delivering vaccines.[27] A systematic plan to improve the immunization delivery system is currently under development.

SUMMARY

Although the United States has made considerable progress during the past 20 years in understanding the effects of environmental hazards on human health, further advances are needed. Substantial improvements have included cleaning up outdoor air pollutants, removing known carcinogens from the food supply, purifying the water supply and abating lead from most pathways to human exposure, as well as controlling communicable diseases. There is growing awareness about the ways in which alterations in the environment in turn pose risks to human well-being. With that realization comes a transformation in understanding environmental health. The

challenge at present is to strengthen the nation's capacities to manage the health threats from environmental exposures as this transformation continues.

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CHAPTER

3

INDIGENOUS PEOPLES

Overview

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Indigenous Americans within the Continental U.S.

■

Indigenous Americans in Alaska

■

Insular Areas of the United States

■

Tribal and State Cooperative Resource Management

OVERVIEW

The cultures in the Western Hemisphere and the Pacific Basin have changed dramatically in the nearly five hundred years since Europeans first came to the Americas and established contact with the indigenous cultures of what is now the United States and its Pacific, Caribbean and insular areas.[1] When the Europeans first arrived, the Indian population numbered in the millions. By 1850, as a result of disease, war and malnutrition the indigenous population had diminished drastically. Today, due to improved health care and a higher birth rate, a composite population of close to two million Native Americans still represent over 500 separate and distinct indigenous cultures.[2] In addition, the majority of the approximately 200,000 Native Hawaiians and 3.7 million inhabitants of the U.S. Pacific, Caribbean and insular areas are considered indigenous.

Preserving the environment has been an essential value of almost all of these native cultures. This chapter is limited to a discussion of common environmental and economic issues confronted by Native Americans in three specified regions: the Indians in the lower 48 continental states (every state except Alaska and Hawaii), the Alaska Natives, and the indigenous populations in the U.S. insular areas. The issues are region specific due to the distinct relationships between the federal government and the indigenous people in each geographic area.

Indians and Alaska Natives

American Indian lands comprise 22.4 million hectares—21.9 million located in the contiguous states, and 500,000 in Alaska. There are 313 federally recognized American Indian tribes living on 280 separate reservations in the United States. While this total includes only one reservation in Alaska, Metlakatla of Annette Island, Alaska also has over 200 additional native villages. In his statement of June 14, 1991, President George Bush reaffirmed the government-to-government relationship between the federal government and tribal governments.[3]

INDIGENOUS AMERICANS WITHIN THE CONTINENTAL U.S.

Legally, Native American Indians hold a unique position in American jurisprudence. Aboriginal right, sometimes called "Indian title," is the claim by Native Americans to exclusive use and occupancy of lands and waters based on ancestral occupation prior to the assertion of sovereignty over the area by the colonies and then by the United States. Indian title can only be overridden by the United States.[4]

When Europeans arrived on the North American continent, hunting, fishing, farming and gathering were vital to Indian life. The great importance of rights to these activities is reflected in an early U.S. Supreme Court case, in which the Court noted that newly arrived Europeans recognized that Indian rights to fish and hunt "were not much less necessary to the existence of the Indians than the atmosphere they breathed."[5] Such rights, also referred to as "subsistence" rights, are much more than mere hunting, fishing and gathering; they are a way of life, and fulfill spiritual as well as economic needs. Although today subsistence rights are perhaps not as vital for some Indians as they once were, hunting and fishing rights still have a symbolic and spiritual meaning to many.[6] In response to the recognition of the cultural, economic and religious importance tribes placed on wildlife, treaty negotiators in the 19th century recognized Indians' rights over their natural resources in exchange for vast tracts of valuable land ceded to the United

States for its non-Indian homesteaders, ranchers, loggers and miners. Overall, U.S. courts have applied longstanding, fundamental principles in interpreting treaties; because of the imbalance in bargaining power at the time of making the treaties, courts have fairly consistently held that Indian treaties must be construed as the Indians would have understood them, and that any ambiguity in the written language should be interpreted in favor of the Indians.[7]

Pursuant to individual treaties, tribes reserved the right to hunt and fish on certain lands. The reservation of hunting and fishing rights by some tribes often was couched in permanent terms, while other tribes received similar privileges that were removable upon a particular event—for example, upon order by the President.[8] In fact, language in treaties regarding retained rights to natural resources varies greatly, both in geographic scope and in definition of the right, because different cultural habits and tribal circumstances influenced treaty negotiations. With respect to off-reservation areas, a treaty affects a total cession of rights unless the treaty explicitly reserves rights in the ceded area for hunting and fishing. On the other hand, for on-reservation areas, tribes reserve all original rights except those expressly ceded by the treaty. In addition, Indian hunting and fishing rights are frequently preserved under the so-called "reserved rights" doctrine, which means that rights in any lands the Indians did not specifically grant to the United States are reserved by them. Some treaties expand the reserved right to areas including the "open and unclaimed" or "unoccupied" lands of the United States; courts have interpreted such terms to include national forests, national parks and some privately owned lands.[9]

Since Indian treaties are federal law, the Supremacy Clause of the U.S. Constitution prevents states from enacting laws that override retained treaty rights. Some treaties explicitly allow Indians exclusive rights to hunt and fish on their own reservations. However, states and tribes often come into a great deal of conflict is in implementing wildlife laws by which states attempt to regulate hunting and fishing outside of reservations. Some state regulation of Indians exercising hunting and fishing treaty rights off-reservation has been upheld, but only when necessary to conserve fish or wildlife resources.

Four basic themes can be underscored to illustrate the nature and scope of the unique relationship between Indian tribes and the federal government. These themes are fundamental reference points for both tribes and the federal government when addressing the challenges of environmental protection, environmental enhancement and economic development on Indian lands.[10]

First, tribes are quasi-independent government entities within the United States, with inherent powers of self-government. Second, their sovereignty is ultimately subject to the plenary power of Congress, giving Congress the ability to regulate and modify the inherent power of the tribes. John Marshall, who served as chief justice of the Supreme Court from 1801 to 1835, characterized this status of tribes as "dependent, domestic sovereign nations." Third, the power to deal with and regulate tribes is wholly a federal responsibility: the states are excluded unless Congress expressly delegates power to them. Fourth, the federal government has a responsibility for the protection of Indian tribes and properties as defined by treaty, statute and regulation—formally known as the federal trust obligations. The trust obligations have served as the starting points for addressing both the environment and economic development on Indian lands since 1970.

Under its policy of self-determination, the federal government actively promotes the participation of the tribal governments in the planning, execution and management of Indian programs and services. As dependent

sovereign nations, many tribal governments exercise jurisdictional responsibilities for environmental resource protection that are similar to the responsibilities exercised by state governments. Fishery, forest, range, air quality and water quality management are examples of these activities. Tribal governments are recognized as the key to managing the lands held in trust for Indians and for the future course of environmental and economic activities on the reservations.

Environment

The last decade has seen a large increase in the direct involvement of tribal governments in the lower 48 states in environmental resource management as the federal government has implemented national environmental policies. In an exercise of its plenary power, Congress has directed a number of major environmental statutes to be equally applicable to Indian lands, including the Clean Air Act, the Clean Water Act, the Comprehensive Environmental Response, Compensation and Liability Act, the Federal Insecticide, Fungicide and Rodenticide Act, the Resource Conservation and Recovery Act, the Surface Mining Control and Reclamation Act, the Safe Drinking Water Act and the Oil Pollution Act.[11] Tribal governments can apply to the federal government to be accorded primacy in administering four of these statutes in a manner equivalent to state governments. Under appropriate circumstances, tribes may also receive grants from the federal government. These grants provide funds with which the tribes can develop their own regulatory and enforcement codes and ordinances, and carry out various other activities specified under the statutes.

In addition, tribes that meet requirements under U.S. Environmental Protection Agency (EPA) regulations may receive primary enforcement authority for program functions and join with EPA as partners to ensure effective compliance with federal environmental laws. Under this program, tribes may establish environmental management codes and regulations, issue federally enforceable permits, and join with the federal government in taking appropriate enforcement actions. These partnerships are similar to those that state governments are eligible to develop with the federal government.

In carrying out its trust obligation in regard to Indian trust lands, the federal government must ensure the protection and prudent use of natural resources. Waste management projects or any other major land-disturbing activity contemplated by a tribe on reservation trust lands must be in compliance with the National Environmental Policy Act (NEPA), must satisfy land lease requirements and must receive all applicable EPA operating permits.[12]

Economic Development

Many tribes within the contiguous United States have established effective infrastructures that enable economic enterprises to operate on a profit-making basis, while retaining control over tribal lands and natural resources. Federal programs have assisted tribes in developing their internal management capacities. It is vital, however, that the tribal government itself be integrally involved in bringing together an appropriate framework for the tribe's economic, cultural and environmental activities.

Even with many pressing economic and social needs, tribal governments are very careful in weighing the prospective economic benefits against their respect for any affected natural resources. This has not deterred development of their natural resources. Revenues earned for the mining of oil, coal, gas, and metallic and industrial minerals on all Indian lands amounted to $173 million in 1990.[13] In some cases, different tribes with mutual interests in developing natural resources for economic reasons have banded together to form inter-tribal organizations to ensure that the best technical knowledge for resource development and for mitigating potential

environmental impacts is shared. For example, 44 tribes currently belong to the Council of Energy Resource Tribes. Tribes with substantial commercial agricultural interests have similarly formed the Inter-Tribal Agriculture Council (IAC). During 1991, the IAC represented 64 member tribes, which controlled 17.2 million hectares of Indian lands in the contiguous United States and approximately half of the 17.6 million hectares to be transferred to native corporations in Alaska. The gross value of crops grown on Indian lands is estimated at over $750 million annually. In addition, livestock grazing revenues amount to $63 million annually.[14] Tribes with timber resources have been very active in the Inter-Tribal Timber Council. The direct, indirect and induced employment generated by timber harvesting activities are estimated at $500 million annually.[15]

As tribes have developed their natural resources, tribal governments have on occasion also banded together to mitigate impacts on the environment within their reservations. For example, the Navajo Tribe established the Navajo Environmental Protection Agency, and the Campo Band of Mission Indians in California established an office to develop environmental regulations that would exceed federal and state of California standards. The Campo initiative is directed toward protecting the environment as the Band pursues the economic development benefits of commercial waste management. Other California bands are planning similar ventures and must implement similar environmental protection measures. Today, environmental compliance costs borne by economically advanced tribes comprise about 20 percent of the total revenue from natural resources development.

Issues

Native American settlements can be found in most states, and the environmental issues confronting Native Americans span the spectrum. Because the largest percentage of the Native American population and Native American lands are in the western part of the United States, this discussion will focus on some of the issues facing many tribes in this area.

Drinking water supplies in most of the reservations in the Western states largely come from groundwater. Not only is groundwater in short supply in many of these areas, it is also at risk of contamination from domestic sources, mining, other industrial activities and excessive use of agricultural chemicals. As a result, water rights (which have not, in all cases, been finally determined), and water supply development and protection are a high priority for many Indian communities. Surface water quality and in-river water flows are also critical to the survival of natural resources used for subsistence and other purposes by indigenous peoples. The Indian tribes of the Pacific Northwest coast region have seen major reductions in fish and wetland plant harvests as water is diverted for power plants and irrigation.

Proposals for siting commercial treatment and disposal facilities for solid and hazardous waste on trust lands have also raised concerns. The siting of a limited number of such facilities on trust lands will require extensive federal/tribal cooperation, coordination and regulation. Tribal management, regulatory and enforcement capacities in this area vary greatly. The federal government reviews environmental impacts and determines needed protective measures before approving contracts or leases for facilities. For hazardous waste facilities, the federal government requires compliance with strict safety standards.

CASE STUDY

COOPERATIVE MANAGEMENT OF SALMON RESOURCES

The State of Washington

One of the most comprehensive and successful examples of tribal/state/federal cooperation in resource management is the management of salmon resources in the state of Washington. Tribal fishing rights guaranteed by treaty are found in a series of treaties negotiated in the 1850s by Territorial Governor Isaac Stevens with a number of tribes in the Northwest. These Indian fishing rights were ignored in the settlement and development of the region, leading tribes to seek redress in the courts.

Fisheries management in the area was changed fundamentally in 1974 when Judge George Boldt issued his ruling in *U.S. v. Washington*. In this decision, Indian treaty fishing rights were reaffirmed and the tribes were established as co-managers of the resource. Legal battles with the state of Washington continued into the 1980s, however, as the salmon fishery resource continued to decline. By default, fishery management fell to the court, with state and tribal biologists constantly at odds. It was soon apparent to all parties that if the fish resource was of primary concern, the job of managing it must be removed from the hands of the court and placed back into the hands of professional tribal and state managers.

In 1985 a tribal/state plan for cooperative management of fisheries in Puget Sound was jointly developed and approved by the federal court under *U.S. v. Washington*. Today, litigation over fisheries is the exception rather than the rule in managing this key resource.

The tribal contribution to this partnership is substantial. In 1976, tribal hatchery releases for the 20 treaty tribes who are members of the Northwest Indian Fisheries Commission (NWIFC) in the state of Washington totalled 9,929,000 fish. In 1990, the tribal releases totalled 42,779,000 fish. In addition, tribal biologists participate in all facets of fishery management and are expanding their efforts into broader water quality programs as well. This is reflected in the 1990 Lake Chelan agreement for comprehensive water resources management, and in the non-point source pollution control project currently being conducted by the NWIFC in cooperation with state and local governments, with funding from the U.S. Environmental Protection Agency.

INDIGENOUS AMERICANS IN ALASKA

Some natives living in rural Alaska represent perhaps the last surviving aboriginal culture in the United States, living traditional subsistence lifestyles as did their ancestors for thousands of years. In comparison to most Indians in the contiguous United States, many Alaska Natives depend on the land for a significantly greater proportion of their food, clothing, tools and materials. Given the remoteness, lack of infrastructure, and high cost of delivering modern services and goods to Alaska Native villages, their economies often involve the trade and exchange of subsistence resources to supplement the minimal cash resources available to meet basic needs. As a result, subsistence opportunities to many Native Alaskans are a matter of survival.

Unlike Indian tribes in the 48 contiguous U.S. states, Alaska Natives did not exchange aboriginal rights for recognition of tribal lands by treaty. U.S. policy of signing treaties with Indian tribes ended shortly after Alaska

was purchased from Russia in 1867. Before Alaska became a state, in the late 1950s, international treaties and federal statutes governing wildlife resources included provisions to protect native subsistence uses. For example, Alaska's first territorial game law in 1902, exempted native subsistence uses. Federal involvement in Alaska Native affairs was minimal and no further protection appeared to be necessary. However, several factors, starting with the Alaska Statehood Act, began to conflict with aboriginal land claims and subsistence activities by Alaska Natives.

In 1959, Alaska became a state. Controversy over Alaska's land selections pursuant to the Statehood Act, coupled with the discovery of oil on state-owned land on the North Slope, heightened the need to resolve Alaska Native land claims. Natives objected to many of the state's land selections, and top-filed dozens of land claims covering nearly 80 percent of the land base in Alaska. In response, Congress in 1971 passed the Alaska Native Claims Settlement Act (ANCSA) which extinguished all native aboriginal land claims, as well as aboriginal hunting and fishing rights in Alaska.

Under ANCSA, the federal government was to transfer to native ownership approximately 44 million acres of land and $962.5 million in compensation. ANCSA also set up native profit-making corporations organized under the laws of the state of Alaska to manage the land and money distributed pursuant to the Act. In doing so, Congress decided that native profit corporations would own, protect and enhance their own lands as would any other private landowner. Although the federal government does hold allotments for individual natives in trust, it does not hold native corporate lands in trust. Potential alienation of these lands from native control is an ongoing concern for many Alaska Natives.

ANCSA was hailed as a new approach to the resolution of aboriginal land claims, giving the natives land and capital controlled by native corporations. However, while ANCSA extinguished aboriginal hunting and fishing rights in Alaska, Congress left it to the federal government and the State of Alaska to implement policies protecting native subsistence activities. Although Congress took such protective steps as exempting Alaska Natives from certain provisions of the Marine Mammal Protection Act and the Endangered Species Act, the state of Alaska and other entities did not, to the satisfaction of Congress, protect the subsistence activities of Alaska Natives.

For example, in 1976, following the study of a decline in the Western Arctic caribou population, the state fish and game department issued a moratorium on caribou hunting for much of northwest Alaska. This had a great impact on certain Alaska Natives. Shortly thereafter, the International Whaling Commission proposed a moratorium on the hunting of bowhead whales, which, like caribou, was a major source of subsistence for Alaska Natives. Eventually, the Commission lifted the moratorium in exchange for an agreement by the Alaska Natives that they would limit their annual subsistence hunting of whales.

In 1980, in response to the need to designate and conserve certain public lands in the state of Alaska, Congress passed the Alaska National Interest Lands Conservation Act (ANILCA). The Act contains a number of provisions relating to the conservation of federal lands, including the establishment of new units of the National Park, National Forest and National Wildlife Refuge systems. In addition, Title VIII of ANILCA provides federal protection for subsistence hunting and fishing on federal lands. In particular, it gives priority to subsistence uses by rural residents of Alaska, both natives and non-natives, on public lands in time of reduced wildlife populations.

The passage of ANILCA was a clear indication that Congress recognized the need for rural residents in Alaska to be provided a preference

for the taking of subsistence resources on public lands. ANILCA makes the taking of fish and wildlife for subsistence uses on public lands a priority over the taking of fish and wildlife for any other purpose on such lands. "Subsistence uses" are defined as the "customary and traditional uses by rural Alaska residents of wild, renewable resources" for a variety of uses. Subsistence management responsibilities on federal public lands in Alaska have been assumed by the federal government, while subsistence uses on Alaska state property and private lands are being managed by the state.

By continuing to provide the opportunity for subsistence uses by rural residents of Alaska, native and non-native, on the public lands, ANILCA has recognized that such use is essential to rural residents' physical, economic, traditional and cultural existence. In most cases, practical alternative means are not available to replace the food and other items gathered from fish and wildlife for rural residents dependent on subsistence uses. ANILCA also provides that rural residents who have personal knowledge of local conditions and requirements are to have a meaningful role in the management of fish and wildlife and of subsistence uses on the public lands in Alaska.

Environment

With the exception of the Superfund Program, Alaska Native villages are not eligible under federal environmental laws to exercise authority similar to that of state governments. However, as private landowners, Alaska Natives exercise direct control over both surface and subsurface lands they own.

Economic Development

Profit corporations were established by ANCSA and were intended as mechanisms for attaining economic self-sufficiency. Given ANCSA's provisions, however, not all Alaska Natives are shareholders and, as a result, do not share in the economic benefits of corporate ventures. The role that economic development will play is unclear and is becoming an issue for many Alaska Natives.

INSULAR AREAS OF THE UNITED STATES

Five jurisdictions—American Samoa, Guam, the Commonwealth of the Northern Mariana Islands, Puerto Rico and the U.S. Virgin Islands—constitute the major populated insular areas of the United States. The people of these islands represent distinct cultural and ethnic entities. Each has a unique historical and legal relationship with the United States, which establishes the basis for the manner in which it is administered.

The United States officially encourages the political self-determination and economic and social development of the insular areas. Article IV of the U.S. Constitution, provides that Congress shall "make all needful Rules and Regulations respecting the Territory . . . belonging to the United States."

The U.S. emphasis on self-determination has resulted in a different type of political status in each insular area.[16] Puerto Rico and the Northern Mariana Islands have commonwealth status based on the terms of an agreement voted on and accepted by the people of the area, and approved by an act of the U.S. Congress. Guam and the U.S. Virgin Islands are governed under the terms of separate organic acts adopted by the U.S. Congress. American Samoa is governed under its own constitution, adopted in 1960, and approved by the secretary of the interior under authority delegated to him by Executive Order 10264, dated June 29, 1951.

In addition, the United States is also responsible, under the terms of the 1947 Trusteeship Agreement with the United Nations, for the administration of the Trust Territory of the Pacific Islands. Palau is the only district remaining in this status today. As such, Palau must comply with

many federal environmental laws, rules and regulations in the same fashion as areas under U.S. sovereignty. In addition, Palau is also eligible for many federal programs, usually under the same conditions as states.

Environment

Today, all the insular areas of the United States are islands located in an ocean environment, often thousands of miles from the mainland. Most federal programs address environmental standards for contiguous states with vast amounts of land and large populations. The island environment of limited land resources and small populations surrounded by ocean often requires unique solutions to address local environmental concerns. The unique characteristics of these island environments are important considerations as Congress and the federal agencies formulate and administer national law.

The five major, populated insular areas over which the United States exercises sovereignty, in addition to Palau, all enjoy a substantial measure of self-government, with a locally elected chief executive, a legislative branch with broad law-making authority and an independent judiciary. In general, federal laws concerning the environment apply to the insular areas, usually on the same terms as they apply to the states of the Union. These insular governments exercise jurisdictional authority for environmental resources much in the same manner as it is exercised by state governments. Similarly, federal financial assistance programs for environmental projects are available to the insular areas are usually based on the same criteria that apply to states.

Partnerships between the federal government and insular governments are very similar to those which state governments can develop with the federal government. For example, insular governments may develop environmental regulatory capabilities under federal agency guidelines to receive primary enforcement authority for a number of federal environmental laws. Insular governments establish environmental management codes and regulations, and join with the federal government in taking appropriate enforcement actions.

In addition, the insular governments of the Pacific and Caribbean, with the exception of Palau, have federally approved coastal zone management programs. Marine and coastal research, education and outreach programs occur at Jobos Bay, the National Estuarine Research Reserve and in American Samoa's Fagatele Bay National Marine Sanctuary.

Economic Development

The U.S. government has worked with the governments of the insular areas to protect their environment and develop their natural resources. The federal executive branch, recognizing the insular areas' desire for more certainty in the access of locally produced goods to the U.S. market, supports the continuation of preferential trade benefits for products made in the insular areas.

American Samoa, Guam, the U.S. Virgin Islands, and the Commonwealth of the Northern Mariana Islands have made rapid strides in recent years toward increased self-government and economic self-sufficiency. Both Guam and the Northern Mariana Islands are experiencing a boom in Japanese tourism, resulting in significant economic benefits and improved living standards for local residents. The U.S. Virgin Islands continue to benefit from North American-based tourism and have largely recovered from a devastating hurricane that occurred in September 1989. American Samoa is also planning to expand tourism facilities, but continues to depend on canned tuna exports for private-sector employment.[17] Puerto Rico, over the last 45 years, has transformed itself from an economy based upon sugarcane and its products to an economy based upon a wide range of manufactured goods.

Puerto Rico: Puerto Rico is unique among the U.S. insular areas in that it is within the U.S. customs territory. Because of that fact, its relatively large population of 3.6 million, and its ease of access by air and sea to the mainland United States, Puerto Rico's diversified economy more closely resembles that of a U.S. state. Through its Commonwealth political arrangement, which has remained basically unchanged since 1952, Puerto Rico also exercises virtually the same control over its internal affairs as do the 50 states.[18] Manufacturing is the largest single sector in Puerto Rico's economy, accounting for approximately 40 percent of the gross domestic product. The most important industries located in Puerto Rico are apparel, pharmaceutical products, electronics, food products, and medical and scientific instruments.

American Samoa: In spite of its distant location and pronounced cultural differences, American Samoa's economic development is firmly linked to that of the United States. Sixty-seven percent of all imports to the private sector of the territory originated in the United States in 1988—approximately $334 million. Fiscal year (FY) 1990 revenues for the American Samoa government (ASG) included $46.4 million from local revenues, $80 million from federal grants (including $24.1 million in hurricane disaster relief) and $1.7 million from other financing sources. Fish processing is the main economic activity. In 1988, American Samoa generated approximately $368 million in exports, almost exclusively by the tuna canneries located in Pago Pago.

Guam: Until recently, military spending was the main source of revenue in Guam. However, since the mid-1980s, the burgeoning tourism industry has become the main revenue source. Tourism has grown from 6,600 visitors in 1967 to 780,404 in 1990. The total number of tourists is expected to reach 1,000,000 by 1993. At present, Guam is experiencing a tremendous construction boom, particularly in the private sector. The construction of several new hotels is underway, and many other hotels are expanding their facilities. There are currently more than 4,000 hotel rooms, and the number is expected to reach 10,000 within a few years. Federal expenditures (mostly military) in 1989 amounted to more than $680 million of which more than $300 million went for salaries and more than $100 million for purchases in the local economy. Guam also benefits from tax rebates of all federal income taxes paid by its federal employees (mostly military).

The U.S. Virgin Islands: The U.S. Virgin Islands government has an annual operating budget of almost $500 million. The principal industry of the Virgin Islands is tourism. Between 1970 and 1990, tourist expenditures in the islands increased more than 30-fold and are now estimated to be over $500 million annually. In 1990, 1,837,642 tourists arrived in the Virgin Islands, about two-thirds of whom were day visitors on cruise ships.

Commonwealth of the Northern Mariana Islands: The government of the Commonwealth of the Northern Mariana Islands (CNMI) benefits substantially from U.S. financial assistance. A seven-year financial agreement with the United States for the years 1986-1992 entitles the Commonwealth of the Northern Mariana Islands to $228 million for capital development, government operations and special programs. Between 1982 and 1990 the CNMI experienced dramatic economic growth. Local revenues increased from $14 million in FY 1982 to $111 million in FY 1990. The gross island product for the CNMI was $512 million in FY 1989. In comparison, operational funds from the Department of the Interior (DOI), as part of the

DOI-Covenant financial assistance agreement, have remained fairly constant, at about $34 million in 1990 dollars.

Commercial activity in the Northern Mariana Islands has increased steadily in the last few years. The CNMI's economic development continues to show consistent and steady growth patterns. Construction has increased and imported construction materials have expanded from $12 million in 1985 to $112 million in 1989. Tourism is the leading earning export with total visitor expenditures equaling approximately 37 percent of the CNMI gross island product. In 1990 more than 417,000 tourists visited CNMI, an increase of 38 percent over 1989.[19]

Issues

As with most populations in the United States, there are a number of environmental issues facing indigenous populations in the U.S. insular areas today. For example, the groundwater upon which most of the insular populations rely is in short supply and at risk of contamination from domestic sources. Other problems facing the insular areas include marine pollution, waste disposal, threats to biodiversity, and destruction of coral reefs and mangrove forests.[20] Federal agencies have assisted the insular areas in addressing these environmental challenges, seeking compliance with federal laws and regulations while encouraging sound economic development. The federal government's approach has been to provide technical assistance as well as direct grants to the insular areas. An example of these cooperative efforts is the Pacific Island Network Program.

THE PACIFIC ISLAND NETWORK

The Pacific Island Network (PIN), a consortium of U.S. federal government agencies, was initiated in 1987 to coordinate the U.S. marine and coastal programs in the U.S. insular areas of the Pacific, the freely associated states and the Trust Territory of the Pacific Islands. PIN's main objective is to make available high quality technical information and expertise related to all aspects of resource planning, management and development.

PIN supports on-island representatives who are housed in various island government agencies. These PIN representatives identify specific technical assistance needs and coordinate with the appropriate federal agency or nongovernmental organization to provide necessary technical expertise on a number of coastal and marine issues. The participating island governments are the Commonwealth of the Northern Mariana Islands, the Federated States of Micronesia, the Republic of the Marshall Islands, the Republic of Palau, Guam and American Samoa.

American Samoa, the Commonwealth of the Northern Mariana Islands, Guam, and the U.S. Virgin Islands have implemented programs to solve their environmental problems. These programs include establishing offices within the executive branch of the insular areas' governments to deal with the specific environmental concerns of the population; preparing coastal zone management plans to encourage governments, businesses and landowners in the insular areas to manage natural resources wisely; and conducting education programs to increase businesses' and landowners' awareness of effluent and solid waste management problems.

Another concern for the insular areas is the siting of treatment and disposal facilities for solid and hazardous wastes. Limited land resources in an island environment have made this a critical issue in most insular areas.

A number of solutions are being explored for these waste disposal problems. They include U.S. federal assistance; environmental impact studies funded by developers; mitigation plans and source reduction measures; and the initiation of agreements with surrounding jurisdictions so that waste treatment and disposal can be managed regionally whenever possible. A more controversial solution involves efforts by the governments to establish waste incineration, recycling and disposal enterprises on remote islands. Commercial waste treatment and disposal facilities offer the promise of employment and revenues; they can, however, create financial and environmental liabilities.

CASE STUDY

TUNA CANNERIES

Pago Pago Harbor, American Samoa

Two major fish canning facilities discharge their waste into Pago Pago Harbor in American Samoa, contributing to the degradation of water quality in the harbor. The canneries historically have challenged efforts by the federal and territorial governments to require more stringent controls on their waste discharges.

In 1987, the U.S. Environmental Agency (EPA) issued new permits for the canneries imposing discharge limits based upon American Samoa's water quality standards. The canneries requested evidentiary hearings on the permits. However, the majority of the canneries' request was eventually denied even after an appeal by the canneries. This development created a favorable atmosphere to finally bring about the necessary changes to improve the quality of the harbor.

Although primary enforcement authority for the permits rests with EPA, it was mutually agreed that the territory would take the enforcement lead. After a period of intensive negotiations, the territorial government entered into consent decrees with both canneries in mid-1990. The EPA issued administrative orders which paralleled the consent decrees. Both canneries were initially required to remove certain high-strength waste streams from their discharge to the harbor and to achieve full compliance with the water quality standards by March 1992.

The canneries have complied with the major provisions of the consent decree and have completed a plan to construct a new joint discharge that would halt their waste discharges to the inner harbor. Noticeable improvements in the water quality of the harbor have already been observed, and even greater improvement is expected when the new method of discharge is put into operation.

This example illustrates how the federal and territorial governments can work side by side to impose and enforce environmental standards which bring about real improvements in environmental quality.

TRIBAL AND STATE COOPERATIVE RESOURCE MANAGEMENT

A growing concern that will be faced by all indigenous peoples in the United States during the next two decades is that of establishing cooperative relationships with surrounding jurisdictions. Ecosystems and pollution are rarely confined by political boundaries. Ecosystems that cross reservation boundaries make it necessary for tribes to cooperate with one another and their respective neighbors if they are to protect interrelated

ecosystems. Therefore, the resolution of cross-boundary issues is imperative for every jurisdiction, indigenous or non-indigenous.

During the past several years, there have been significant efforts at cross-boundary cooperation by indigenous populations in all regions among tribes, states and the majority populations. Among the examples:

- Twenty Indian tribes who belong to the Northwest Indian Fisheries Commission in the state of Washington have come together and are working with a variety of non-Indian jurisdictions to develop a non-point source water pollution control project in order to protect local fisheries;

- The Menominee Tribe has entered into a cooperative agreement with the state of Wisconsin that calls for tribal-state cooperation in the cleanup of spills of hazardous chemicals; and

- Four Pacific insular governments and the state of Hawaii belong to the Pacific Basin Development Council, which is working on a variety of common issues such as the development of coordinated positions on Pacific fishing policies, air service, the protection of natural resources and the environment, and the development and exploitation of new technologies.

SUMMARY

The lands of the American Indians and Alaska Natives encompass a broad variety of ecosystems including wetlands, deserts, range lands, mountains, river systems and seashores. The island environment of the indigenous peoples in the United States insular areas includes wetlands, mountains, forests, ocean reefs and seashores. Protecting all of these inter-related ecosystems and integrating protective measures with economic development is a complex challenge that must be met if native cultures are to survive and flourish into the 21st century.

Although some of these lands remain pristine today, economic growth still needs to be reconciled with preserving environmental quality. Thus, environmental problems caused by earlier and future economic development projects must be mitigated. In addition, if environmentally sensitive economic development practices are not developed and implemented, the needs of existing and future populations cannot be fully met. It is imperative that efforts continue to assist indigenous populations in the areas of environmental monitoring, resource conservation, waste treatment and disposal, environmental education and environmentally responsible infrastructure development.

A major step toward achieving this goal is being realized through the development of cross-boundary cooperation and the leadership of tribal governments in representing indigenous environments and economic interests. Indigenous populations are entering into cooperative relationships with a number of federal, state, and local jurisdictions in order to seek mutual solutions to complex problems they share. Some efforts, such as the management of salmon in the state of Washington are receiving national attention as examples of outstanding environmental management. These projects clearly demonstrate that cooperative efforts can be very effective and suggest that the route to environmental protection and resource management for all people in the United States lies in the direction of cooperative ecosystem management.

In the next 20 years, it is likely that the governments of the indigenous cultures of the United States will spearhead the effort to develop

their resource and environmental management infrastructures. Accordingly, cooperative activities between indigenous and non-indigenous jurisdictions will most probably increase. Indigenous populations in the United States insular areas will need to establish cooperative relationships with surrounding jurisdictions as part of a coordinated global and national effort. It is clear that all Americans will benefit as indigenous cultures assume an increasing role as partners in the national system for environmental management.

Endnotes:

1. Insular areas are those which are not states or parts of states but which are under the sovereignty of the United States.
2. U.S. Department of Commerce, 1990 Census.
3. This policy was first articulated by President Richard Nixon and then officially reaffirmed by Presidents Jimmy Carter and Ronald Reagan. President George Bush on June 14, 1991, stated: "This [government-to-government] relationship is the cornerstone of the...Administration's policy of fostering tribal self-government and self-determination."
4. "*Amoco v. Gambell*: Aboriginal Rights On The Outer Continental Shelf: Reopening Alaska Native Claims," *Natural Resources Journal* vol. 28 (Summer 1988): p. 623.
5. *United States v. Winans*, 198 U.S. 371 (1905).
6. "*Amoco Production Co. v. Village of Gambell*: Federal Subsistence Protection Ends at Alaska's Border," *Environmental Law* vol. 18 (1988): p.635.
7. "Native American Indians and Federal Wildlife," *Stanford Law Review* vol. 31 (1979): p. 375.
8. *Treaty With The Menominees*, February 8, 1831, 7 Stat. 342.
9. "State v. Cutler: Limitations On Indians' Hunting Rights In Idaho," *Idaho Law Review*, vol. 23 (1986-1987): p. 327.
10. William C. Canby, Jr., *American Indian Law In A Nutshell*, 2nd edition (St. Paul, Minnesota: West Publishing Co., 1988): p. 318.
11. J. Royster and Rory Snow Arrow Fausett, "Control of the Reservation Environment: Tribal Primacy, Federal Delegation and the Limits of State Intrusion," *Washington Can Review* vol. 64, no. 3 (July 1989): pp. 581-622.
12. For a more in-depth discussion of NEPA, please refer to Chapter 8.
13. For all Indian lands other than those mandated by tne Osage Nation, U.S. Department of the Interior, Minerals Management Service, *Mineral Revenue Management in 1990* (Washington, D.C.: 1991), p. 83. For the Osage Nation, U.S. Department of the Interior, Bureau of Indian Affairs, Osage Indian Agency.
14. Source for crops and grazing: U.S. Department of the Interior, Bureau of Indian Affairs, *Natural Resource Information System: Inventory and Production Report—Calendar Year 1989* (February 1991), p. 4.
15. U.S. Department of the Interior, Bureau of Indian Affairs, Division of Forestry, *Annual Economic Benefits Derived from Indian Forest Resources: 1989 Update*, (Washington, D.C.: February 1990).
16. Act of July 3, 1950, 64 Stat. 319, and Act of July 3, 1952, 66 Stat. 327 (Puerto Rico) Organic Act of Guam, 48 U.S.C. 1421 et seq. Revised Organic Act of the Virgin Islands. 48 U.S.C. 1541 et seq. 48 U.S.C. 1661, 1662a (American Samoa).

17. U.S. Department of the Interior, Office of Territorial and International Affairs (OTIA), *Fact Sheets* (Washington, D.C.: 1991), unpaginated.

18. "Prospectus, Commonwealth of Puerto Rico Public Improvement Bonds of 1991," Appendix I (December 1990), p. 1.

19. U.S. Department of the Interior, Office of Territorial and International Affairs (OTIA), *Fact Sheets* (Washington, D.C.: 1991), unpaginated.

20. Norman Lovelace, "Pacific Pollution: Trouble in Paradise," *EPA Journal* (Washington, D.C.: U.S. Environmental Protection Agency, December 1987): pp. 23-25.

PART II

THE ECONOMY OF THE UNITED STATES

CHAPTER

4

ECONOMICS, ENERGY AND AGRICULTURE

A. Economic Development and the Environment

■

B. Energy and Environmental Quality

■

C. Agriculture in the U.S. Environment

—A—
Economic Development and the Environment

Overview

Economic growth and environmental quality are two of the nation's most important objectives. Between 1972—when the Stockholm Conference was held—and 1990, the U.S. gross national product (GNP) grew 2.6 percent annually. During these years, the share of GNP devoted to controlling pollution abatement expenditures rose steadily from 0.9 percent in 1972 to 2.1 percent in 1990. This substantial increase in abatement expenditures reflects a strong national commitment to environmental quality. Spending for pollution control is expected to continue growing over the next decade, both in absolute terms and as a share of GNP. Such growth will create additional incentives to choose carefully and wisely those specific environmental goals, production technologies, and regulatory practices that allow both a strong economy and a clean, safe environment.

Aggregated information on topics such as gross national product, saving, foreign debt held in the United States, international trade, technology development and transfer, and the costs and benefits of environmental improvement as discussed in this chapter necessarily omits many details of success and failure. A few of these details are addressed in case studies devoted to changes in energy pricing in the United States, debt-for-nature swaps, the costs and benefits of eliminating lead in gasoline, and the role of the United States in technology cooperation relating to the international phaseout of chlorofluorocarbons. The remaining sections of the chapter address two sectors that are critical to the integration of economics and environment—the agriculture and the energy sectors.

COMPREHENSIVE REVISION OF THE NATIONAL INCOME AND PRODUCT ACCOUNTS

In December 1991, the U.S. Department of Commerce, Economics and Statistics Administration, Bureau of Economic Analysis, introduced a comprehensive revision of the national income and product accounts. Two of the several major changes incorporated in the revision are a shift to the use of gross domestic product (GDP), rather than gross national product (GNP), as the primary measure of production and a shift in the base period from 1982 to 1987 for the price adjustment.

GDP covers the goods and services produced by labor and property located in the United States, whether supplied by U.S. residents or by foreigners. GNP covers the goods and services produced by labor and property supplied only by U.S. residents, whether located in the United States or abroad. GDP is the primary measure of production in the U.N.'s System of National Accounts, the set of international guidelines for economic accounting that the U.S. economic accounts are moving toward during the 1990s.

The preparation of this report was completed before the release of the comprehensive revision; consequently, most of the chapter discussions utilize the GNP concept based on 1982 dollars. For the United States, the levels of GDP and GNP differ little, primarily because the value of the property owned abroad by U.S. residents less the value of the property owned by foreigners in the United States has been small relative to the size of the U.S. economy. The shifts in the base year for indexing also create minor variations in the estimates of the rates of growth of economic activity. The comprehensive revisions do not change the basic trends identified in this report.

Economic Development

Within the United States, average per capita disposable income in constant (1982) dollars increased from $8,562 in 1972 to $11,508 in 1990.[1] The underlying basis for this increase was an average annual growth of 2.6 percent in real output from the U.S. economy from 1972 to 1990, as measured by the rate of increase in constant-dollar gross national product (i.e. "real" GNP).

Labor productivity—measured by output per hour in the non-farm business sector (excluding housing)—is a basic determinant of economic growth. Labor productivity increased at an average annual rate of 0.9 percent during the 1972 to 1990 period. Exhibits 4a.1 and 4a.2 show the annual rates of growth of real GNP and labor productivity from 1972 to 1990.[2] The rate of labor productivity growth during this period appears to reflect some slowing in growth of the capital-labor ratio after the rapid growth experienced during U.S. recovery from the Great Depression and World War II.[3] Factors influencing growth in output per hour include the rising share of services in total U.S. output and the changing demographic and education patterns in the labor force. Until the 1970s, increasing portions of the labor force were young people and recent immigrants. These trends are changing as the baby-boom generation ages, so productivity growth as traditionally measured should rise. Preliminary methods of incorporating environmental improvements into productivity measures indicate that productivity growth may be understated.[4]

Gross National Product and Non-farm Business Productivity
(Percent change)

Year	Real GNP	Productivity
1972	5.9	3.1
1973	5.2	2.1
1974	-0.5	-2.0
1975	-1.3	1.9
1976	4.9	2.7
1977	4.7	1.7
1978	5.3	0.9
1979	2.5	-1.5
1980	-0.2	-0.4
1981	1.9	1.0
1982	-2.5	-0.9
1983	3.6	2.9
1984	6.8	2.2
1985	3.4	1.3
1986	2.7	2.0
1987	3.4	1.1
1988	4.5	2.5
1989	2.5	-0.5
1990	1.0	-0.6
Average Annual Growth Rate	2.6	0.9

Source: Bureau of Economic Analysis, Economics and Statistics Administration, U.S. Department of Commerce, and Bureau of Labor Statistics, U.S. Department of Labor.

Exhibit 4a.1

As indicated in Exhibits 4a.3 and 4a.4, national saving as a share of GNP has declined since 1972. However the rate of real investment in the economy has remained strong. The gap between U.S. saving and investment was filled by foreign capital inflows into the U.S. economy.

Details pertaining to the product and sector components of GNP for the 1972-1990 period are provided in Exhibits 4a.5 through 4a.8.

The environmental character of economic development is not directly measured in the national income and product account elements described above. Also not measured are many dimensions of the link between the economy and the environment such as the costs and benefits of environmental improvement, international trade, technology transfer and international assistance. These topics are discussed in the following sections.

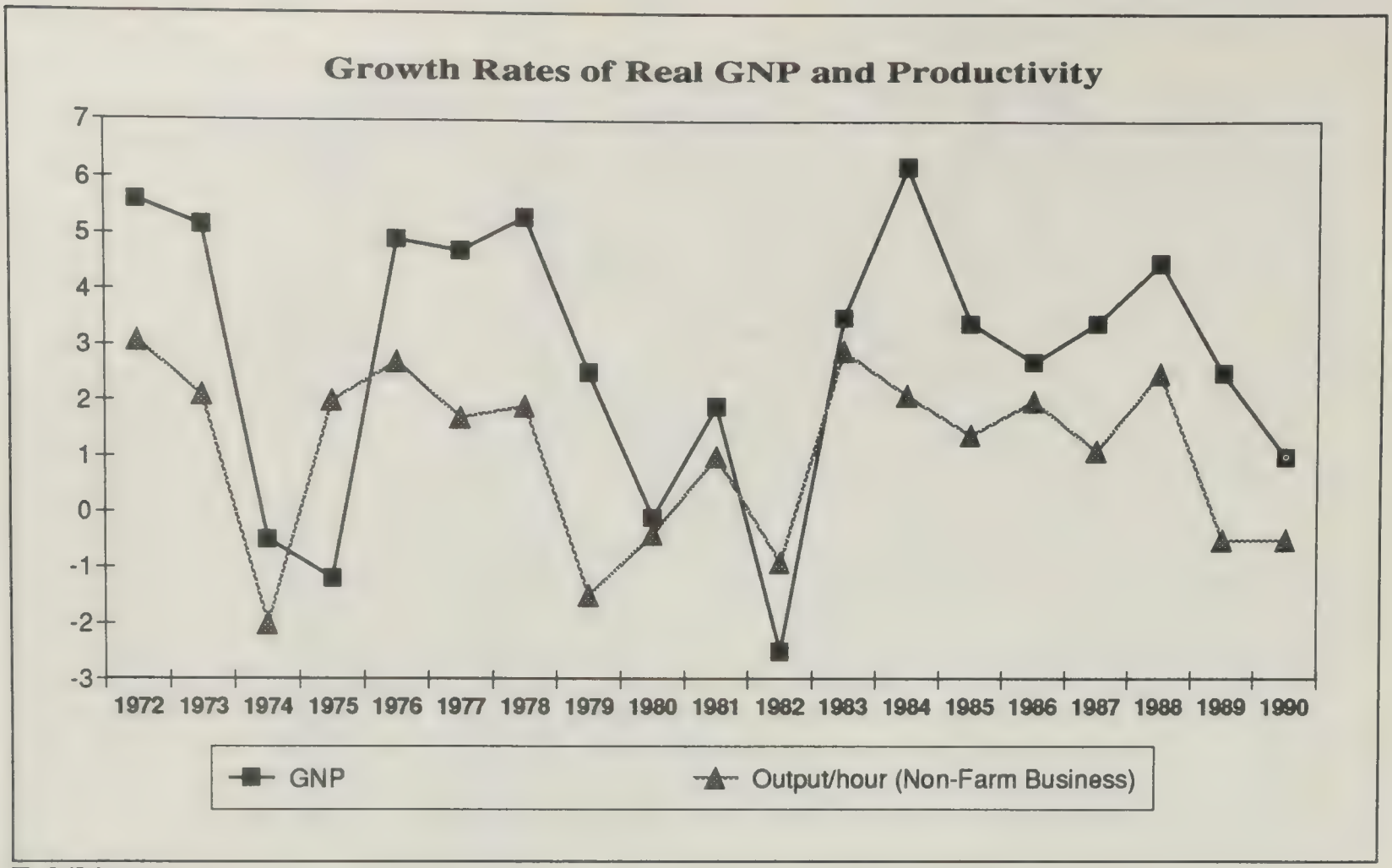


Exhibit 4a.2

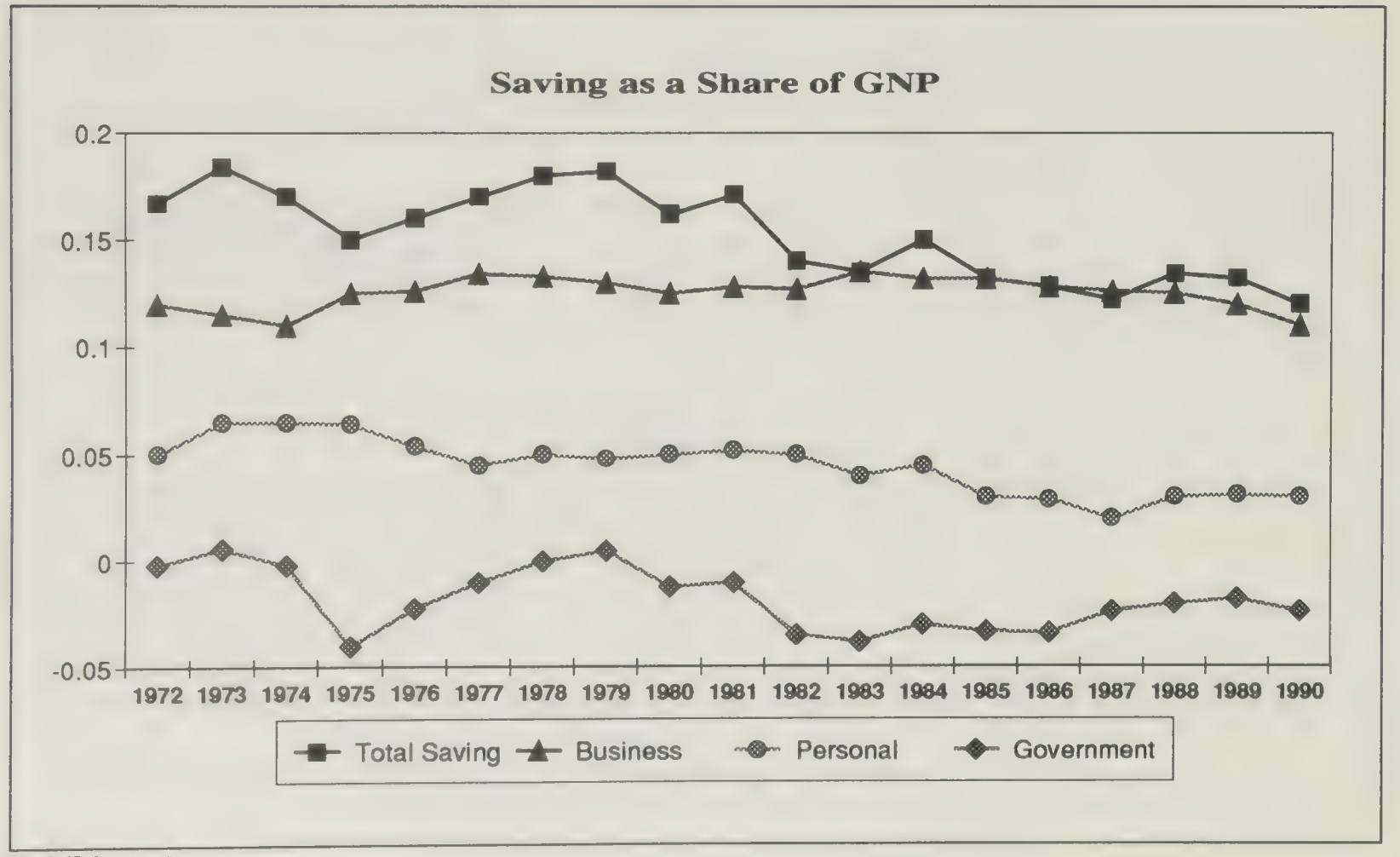


Exhibit 4a.3

SAVING, TOTAL & COMPONENTS, AS SHARE OF GNP

Year	Total saving	Personal saving	Business saving	Gov't. saving	Federal	State & local
1972	0.165	0.051	0.117	-0.003	-0.014	0.011
1973	0.185	0.065	0.114	0.006	-0.004	0.010
1974	0.168	0.066	0.107	-0.003	-0.008	0.005
1975	0.149	0.065	0.124	-0.041	-0.043	0.003
1976	0.159	0.054	0.127	-0.021	-0.030	0.009
1977	0.169	0.046	0.133	-0.010	-0.023	0.014
1978	0.182	0.049	0.133	0.000	-0.013	0.013
1979	0.183	0.047	0.131	0.005	-0.006	0.011
1980	0.163	0.050	0.125	-0.013	-0.022	0.010
1981	0.171	0.052	0.128	-0.010	-0.021	0.011
1982	0.141	0.049	0.127	-0.035	-0.046	0.011
1983	0.136	0.038	0.136	-0.038	-0.052	0.014
1984	0.151	0.044	0.135	-0.028	-0.045	0.017
1985	0.133	0.031	0.134	-0.033	-0.049	0.016
1986	0.124	0.030	0.129	-0.034	-0.049	0.015
1987	0.123	0.020	0.126	-0.024	-0.035	0.011
1988	0.135	0.030	0.124	-0.020	-0.029	0.010
1989	0.133	0.033	0.117	-0.017	-0.026	0.009
1990	0.120	0.033	0.111	-0.024	-0.030	0.006

Source: Bureau of Economic Analysis, Economics and Statistics Administration, U.S. Department of Commerce.

Exhibit 4a.4

REAL GNP BY SECTOR[a]

(Thousand-millions of 1982 dollars)

Year	Farm	Non-farm bus. less housing	Manufac-turing	Services (private)	Housing	Households & insti-tutions	Government	Rest of the world
1972	62.0	1949.8	561.2	320.0	178.2	91.2	307.1	23.7
1973	61.1	2071.5	621.3	340.2	185.0	93.4	309.3	32.2
1974	60.7	2032.5	591.6	347.5	194.0	93.9	315.7	35.9
1975	64.8	1985.3	547.5	352.4	195.2	96.4	319.6	29.3
1976	62.5	2106.5	600.6	367.7	200.1	97.0	321.9	33.0
1977	62.2	2229.8	664.8[b]	399.6[b]	205.2	98.0	326.0	37.4
1978	61.0	2364.7	694.7	421.5	216.2	101.0	332.8	42.1
1979	64.6	2409.1	712.3	436.9	224.1	103.7	336.5	55.7
1980	64.2	2380.4	673.9	498.9	232.6	107.3	341.2	55.5
1981	75.7	2419.1	578.6	463.8	240.5	109.9	343.9	55.2
1982	77.0	2337.5	634.6	463.6	243.8	112.7	343.9	51.2
1983	61.3	2455.0	674.2	488.4	248.8	114.9	346.3	47.9
1984	68.5	2660.9	752.4	509.7	255.7	117.6	349.8	43.9
1985	79.4	2762.5	779.2	538.6	265.6	121.3	357.4	36.9
1986	84.1	2843.3	803.4	565.8	272.4	125.7	363.5	30.5
1987	83.8	2963.6	852.2	592.6	281.7	129.5	370.4	25.3
1988	75.3	3133.0	917.4	623.3	289.2	137.5	377.2	28.3
1989	78.8	3196.0	929.0	652.3	296.9	146.2	383.5	30.2
1990	80.0	3200.4	n.a.	n.a.	302.1	154.5	389.7	31.9
Average Annual Growth Rate								
	1.4%	2.8%	3.0%	4.3%	3.0%	3.0%	1.3%	1.7%

[a] GNP for manufacturing and services includes the output of nonprofit institutions serving individuals; this output also is included in the column for households and institutions.

[b] There is a break in the series after 1976 due to a revision of the gross product originating (GPO) by industry series.

n.a. Not available.

Source: Bureau of Economic Analysis, Economics and Statistics Administration, U.S. Department of Commerce.

Exhibit 4a.5

GNP AND MAJOR FINAL PRODUCT COMPONENTS

(Thousand-millions of 1982 dollars)

Year	Gross national product	PCE* durable goods	PCE motor vehicles & parts	PCE other durable goods	PCE nondurable goods	PCE services	PCE medical care	PCE other services	Pvt. invest-ment, nres. struct.
1972	2608.5	200.4	98.3	102.1	665.5	756.0	136.0	620.0	109.5
1973	2744.1	220.3	106.7	113.6	683.2	786.1	145.4	640.7	117.7
1974	2729.3	204.9	90.3	114.6	666.1	803.1	151.3	651.8	115.2
1975	2695.0	205.6	91.1	114.5	676.5	829.8	159.9	669.9	102.8
1976	2826.7	232.3	109.6	122.7	708.8	862.8	167.8	695.0	104.4
1977	2958.6	253.9	121.2	132.7	731.4	898.5	177.8	720.7	108.3
1978	3115.2	267.4	125.9	141.5	753.7	939.8	184.8	755.0	119.3
1979	3192.4	266.5	119.4	147.1	766.6	971.2	192.2	779.0	130.6
1980	3187.1	245.9	103.8	142.1	762.6	991.9	200.6	791.3	136.2
1981	3248.8	250.8	106.3	144.5	764.4	1009.0	212.0	797.0	148.8
1982	3166.0	252.7	108.9	143.8	771.0	1027.0	217.8	809.2	143.3
1983	3279.1	283.1	126.8	156.3	800.2	1062.7	222.3	840.4	127.2
1984	3501.4	323.1	148.0	175.1	825.9	1100.3	232.0	868.3	143.8
1985	3618.7	355.1	164.4	190.7	847.4	1152.3	240.9	911.4	149.5
1986	3717.9	384.4	176.2	208.2	878.1	1183.8	251.5	932.3	130.1
1987	3845.3	391.4	171.1	220.3	892.7	1231.6	266.9	964.7	122.8
1988	4016.9	418.2	182.1	236.1	909.4	1278.9	279.3	999.6	122.4
1989	4117.7	428.0	181.4	246.6	919.9	1309.0	286.1	1022.9	122.4
1990	4157.3	427.4	177.7	249.7	911.1	1343.3	301.5	1041.8	120.9
Average Growth Rate	2.6%	4.3%	3.3%	5.1%	1.8%	3.2%	4.5%	2.9%	0.6%

*PCE = Personal Consumption Expenditures

	Pvt. invest-ment PDE	Residential invest-ment	Chg. in business inventories	Net exports of goods & services	Exports	Imports	Federal purchases gds.& srvs	State & loc. purchases gds.& srvs
1972	167.5	166.6	21.8	-49.4	195.2	244.6	246.0	324.7
1973	199.6	163.4	40.0	-31.5	242.3	273.8	230.0	335.3
1974	202.7	130.2	33.3	0.8	269.1	268.4	226.4	346.8
1975	178.4	114.9	-12.8	18.9	259.7	240.8	226.3	354.6
1976	186.2	140.8	22.1	-11.0	274.4	285.4	224.2	356.0
1977	215.7	168.1	29.1	-35.5	281.6	317.1	231.8	357.2
1978	242.8	178.0	36.8	-26.8	312.6	339.4	233.7	370.4
1979	258.8	170.8	15.0	3.6	356.8	353.2	236.2	373.0
1980	243.0	137.0	-6.9	57.0	388.9	332.0	246.9	373.6
1981	246.4	126.5	23.9	49.4	392.7	343.4	259.6	370.1
1982	223.4	105.1	-24.5	26.3	361.9	335.6	272.7	369.0
1983	233.9	149.3	-6.4	-19.9	348.1	368.1	275.1	373.9
1984	281.4	170.9	62.3	-84.0	371.8	455.8	290.8	387.0
1985	304.0	174.4	9.1	-104.3	367.2	471.4	326.0	405.2
1986	308.3	195.7	5.6	-129.7	397.1	526.9	334.1	427.5
1987	327.0	196.4	22.8	-118.5	451.8	570.3	339.6	439.5
1988	364.8	194.9	23.6	-75.9	534.7	610.6	328.1	452.4
1989	383.7	187.0	23.8	-54.1	593.3	647.4	334.9	463.2
1990	394.6	176.8	-3.6	-33.8	631.5	665.3	343.7	477.1
Average Growth Rate	4.9%	0.3%	*	*	6.7%	5.7%	1.9%	2.2%

*Since these values fluctuate around zero, calculation of growth rates does not provide meaningful information.

Source: Bureau of Economic Analysis, Economics and Statistics Administration, U.S. Department of Commerce

Exhibit 4a.6

RATIO OF FINAL PRODUCT COMPONENTS TO REAL GNP

Year	PCE motor vehicles & parts	PCE other durable goods	PCE nondur. goods	PCE services	PCE medical care	PCE other services	Gross pvt. dom. invst. nres. fixed	Pvt. inv. nres. struct.
1972	0.038	0.039	0.255	0.290	0.052	0.238	0.106	0.042
1973	0.039	0.041	0.249	0.286	0.053	0.233	0.116	0.043
1974	0.033	0.042	0.244	0.294	0.055	0.239	0.116	0.042
1975	0.034	0.042	0.251	0.308	0.059	0.249	0.104	0.038
1976	0.039	0.043	0.251	0.305	0.059	0.246	0.103	0.037
1977	0.041	0.045	0.247	0.304	0.060	0.244	0.110	0.037
1978	0.040	0.045	0.242	0.302	0.059	0.242	0.116	0.038
1979	0.037	0.046	0.240	0.304	0.060	0.244	0.122	0.041
1980	0.033	0.045	0.239	0.311	0.063	0.248	0.119	0.043
1981	0.033	0.044	0.235	0.311	0.065	0.245	0.122	0.046
1982	0.034	0.045	0.244	0.324	0.069	0.256	0.116	0.045
1983	0.039	0.048	0.244	0.324	0.068	0.256	0.110	0.039
1984	0.042	0.050	0.236	0.314	0.066	0.248	0.121	0.041
1985	0.045	0.053	0.234	0.318	0.067	0.252	0.125	0.041
1986	0.047	0.056	0.236	0.318	0.068	0.251	0.118	0.035
1987	0.044	0.057	0.232	0.320	0.069	0.251	0.117	0.032
1988	0.045	0.059	0.226	0.318	0.070	0.249	0.121	0.030
1989	0.044	0.060	0.223	0.318	0.069	0.248	0.123	0.030
1990	0.043	0.060	0.219	0.323	0.073	0.251	0.121	0.029

Year	Private investment PDE*	Residential invest-ment	Net expts of goods & services	Exports	Imports	Federal purchases gds & srvs	State & loc. purchases gds &srvs
1972	0.064	0.064	-0.019	0.075	0.094	0.094	0.124
1973	0.073	0.060	-0.011	0.088	0.100	0.084	0.122
1974	0.074	0.048	0.000	0.099	0.098	0.083	0.127
1975	0.066	0.043	0.007	0.096	0.089	0.084	0.132
1976	0.066	0.050	-0.004	0.097	0.101	0.079	0.126
1977	0.073	0.057	-0.012	0.095	0.107	0.078	0.121
1978	0.078	0.057	-0.009	0.100	0.109	0.075	0.119
1979	0.081	0.054	0.001	0.112	0.111	0.074	0.117
1980	0.076	0.043	0.018	0.122	0.104	0.077	0.117
1981	0.076	0.039	0.015	0.121	0.106	0.080	0.114
1982	0.071	0.033	0.008	0.114	0.106	0.086	0.117
1983	0.071	0.046	-0.006	0.106	0.112	0.084	0.114
1984	0.080	0.049	-0.024	0.106	0.130	0.083	0.111
1985	0.084	0.048	-0.029	0.101	0.130	0.090	0.112
1986	0.083	0.053	-0.035	0.107	0.142	0.090	0.115
1987	0.085	0.051	-0.031	0.117	0.148	0.088	0.114
1988	0.091	0.049	-0.019	0.133	0.152	0.082	0.113
1989	0.093	0.045	-0.013	0.144	0.157	0.081	0.112
1990	0.095	0.043	-0.008	0.152	0.160	0.083	0.115

* PDE = Producers' Durable Equipment

Source: Bureau of Economic Analysis, Economics and Statistics Administration, U.S. Department of Commerce.

Exhibit 4a.7

SHARES OF REAL GNP BY SECTOR[a]

Year	Farm	Non-farm bus. less housing	Manufac-turing	Services (private)	Housing	Households & Insti-tutions	Government	Rest of the world
1972	0.024	0.747	0.215	0.123	0.068	0.035	0.118	0.009
1973	0.022	0.755	0.226	0.124	0.067	0.034	0.113	0.012
1974	0.022	0.745	0.217	0.127	0.071	0.034	0.116	0.013
1975	0.024	0.737	0.203	0.131	0.072	0.036	0.119	0.011
1976	0.022	0.745	0.212	0.130	0.071	0.034	0.114	0.012
1977	0.021	0.754	0.225[b]	0.135[b]	0.069	0.033	0.110	0.013
1978	0.020	0.759	0.223	0.135	0.069	0.032	0.107	0.014
1979	0.020	0.755	0.223	0.137	0.070	0.032	0.105	0.017
1980	0.020	0.747	0.211	0.157	0.073	0.034	0.107	0.017
1981	0.023	0.745	0.178	0.143	0.074	0.034	0.106	0.017
1982	0.024	0.738	0.200	0.146	0.077	0.036	0.109	0.016
1983	0.019	0.749	0.206	0.149	0.076	0.035	0.106	0.015
1984	0.020	0.760	0.215	0.146	0.073	0.034	0.100	0.013
1985	0.022	0.763	0.215	0.149	0.073	0.034	0.099	0.010
1986	0.023	0.765	0.216	0.152	0.073	0.034	0.098	0.008
1987	0.022	0.771	0.222	0.154	0.073	0.034	0.096	0.007
1988	0.019	0.780	0.228	0.155	0.072	0.034	0.094	0.007
1989	0.019	0.776	0.226	0.158	0.072	0.036	0.093	0.007
1990	0.019	0.770	n.a.	n.a.	0.073	0.037	0.094	0.008

[a] GNP for manufacturing and services includes the output of nonprofit institutions serving individuals; this output also is included in the column for households and institutions.
[b] There is a break in the series after 1976 due to a revision of the GPO (i.e., value added) by industry series.
n.a. Not Available.
Source: Bureau of Economic Analysis, Economics and Statistics Administration, U.S. Department of Commerce.

Exhibit 4a.8

CASE STUDY

ENERGY PRICES AND THEIR DEREGULATION

The composition of aggregate growth is strongly influenced by the relative prices of goods and services in the economy. The United States experienced a failure in public policy in the 1970s when it limited the influence of its internal energy markets by imposing a series of price controls.

For example, beginning with the Economic Stabilization Program in the early 1970s, the U.S. petroleum sector was subject to continuous price and allocation controls. Because price controls increase quantities demanded and reduce quantities supplied, they were typically accompanied by non-price rationing mechanisms. In the United States such mechanisms included entitlement regulations and other rules that gave special consideration to small refiners and other special interests. These controls worked against marketplace allocation of available supplies of crude oil and refined products. Natural gas prices had been regulated in a similar manner by the federal government since 1954.

As the market inefficiencies and other adverse effects of price controls became evident, several laws were passed by Congress that decontrolled the prices of oil and natural gas over the decade of the 1980s. Changes in the efficiency of energy use have been directly linked to improved price signals in energy markets. Moderated price increases and the lack of lines at gas stations during the 1991 Persian Gulf War have been attributed in part to the improved functioning of energy markets.

Source: Economic Reports of the President, 1982, 1986, 1991.

The Costs of Environmental Protection

The amount spent in the United States on pollution control is a portion of the economic activity in many of the economic sectors described above. Such expenditures affect income and productivity as well as environmental quality. The economic costs of pollution control in the United States have increased approximately four-fold from 1972 to 1990, reaching a level of $115 thousand-million in 1990, about 2.1 percent of the GNP. This rise in spending parallels an increase in the extent of environmental regulation. One simple indicator of this increase can be found in the U.S. Code of Federal Regulations. In 1975 the U.S. Code contained 2,763 pages on "Protection of the Environment"; in 1990 the same section of the U.S. Code contained 11,087 pages.

Several different measures of pollution control costs and expenditures are presented in Exhibit 4a.9 and compared with GNP or with total capital investments. Projected costs are also presented for two scenarios. Estimated costs for "Present" implementation in the year 2000 assume that existing programs are implemented to the same degree as in 1987. Estimated costs for "Full" implementation in 2000 assume that investments are undertaken to bring about nationwide attainment of the national ambient air quality standard for ozone (now provided for in the Clean Air Act Amendments of 1990) and the fishable/swimmable goals of the Clean Water Act.

The total annualized costs for all pollution control activities in the United States include the operating costs and the interest and depreciation associated with cumulative pollution control investments (at a seven percent rate of interest). They are presented in the first two rows of Exhibit 4a.9. Although total annualized costs are increasing, the rate of increase is slowing.

POLLUTION CONTROL COSTS AND EXPENDITURES
(Thousand-millions of 1990 dollars)

	1972	1987	1990	2000 "Present"	2000 "Full"
Total Annualized Costs	**30**	**98**	**115**	**171**	**185**
Percent of GNP	0.9	1.9	2.1	2.6	2.8
Federally Mandated Annualized Costs	**21**	**77**	**93**	**NA**	**158**
Percent of GNP	0.6	1.5	1.7	NA	2.4
Capital Expenditures	**23**	**35**	**47**	**35**	**45**
Percent of Total Capital Investments	2.5	2.3	2.8	1.7	1.9

Source: U.S. Environmental Protection Agency, *Environmental Investments: The Cost of a Clean Environment*, November 1990.

Exhibit 4a.9

Pollution control costs that are required to meet federal regulations represent about 80 percent of total expenditures. Pollution control investment data for selected years are presented in the final rows of Exhibit 4a.9. The percent of total capital investment spent on pollution control investments, an important measure of economic impact on U.S. capital markets, reached a high in the mid-1970s at about 3.4 percent and has been trending irregularly downward since then.

Five general statements about the cost of a clean environment can be made based on data in the EPA study underlying Exhibit 4a.9:

- National environmental pollution control expenditures are increasing and are approximately one-quarter those for national defense and medical care and one-fifth those for housing.

- Total annualized pollution control costs paid by the federal government are projected to increase, primarily as a result of the cost of hazardous and nuclear waste cleanup at sites managed by the Departments of Defense and Energy. All other shares, particularly the private sector, are expected to decrease.

- Although the percentage share of the costs to be borne by local government is expected to fall slightly relative to that of other economic sectors, a significant increase in the real costs of pollution control is still expected for this sector.

- A major reallocation is expected over the next decade in the percentage of pollution control expenditures on each environmental medium, with a shift from water and air pollution control to land pollution control. This is a result of the major land pollution control laws passed by Congress, beginning in the mid-1970s and greatly expanded in the 1980s. Data on these media shares are presented in Exhibit 4a.10.

POLLUTION CONTROL EXPENDITURES BY MEDIA
(Share of total U.S. expenditures)

	1987	1997
Air and Radiation Costs	28.9 %	27.1 %
Water Costs	42.9	35.7
Land Costs	26.0	33.9
Chemical Control Costs	1.2	1.9
Multimedia Costs	1.1	1.5

Source: U.S. Environmental Protection Agency, *Environmental Investments.*

Exhibit 4a.10

- National expenditures on environmental pollution control, measured as a percentage of gross domestic product, have been higher in the United States than in many West European nations as indicated in Exhibit 4a.11. The total level of U.S. spending on pollution control significantly exceeds that of most other countries, due both to the large size of the U.S. economy and to the relative share of GNP devoted to environmental expenditures.

The overall rising trend in pollution control costs has focused attention in the United States on market-oriented policies that reduce the cost of achieving environmental objectives. Increasing environmental expenditures, while providing benefits in the form of a cleaner environment, also shift resources away from other productive economic activity. Recent U.S. applications of market-oriented environmental policies include the use of tradeable credits for lead in the phaseout of leaded gasoline, the use of taxes to provide an incentive for the phaseout of chlorofluorocarbons, the use of increased financial liability for damage to natural resources, and the use of tradeable allowances for industrial emissions of sulfur dioxide (which is allowed by a provision in the Clean Air Act Amendments of 1990). The emissions trading program of the Clean Air Act Amendments is expected to achieve the same environmental quality goal as alternative regulatory approaches, but with a cost saving of approximately $1 thousand-million dollars per year.

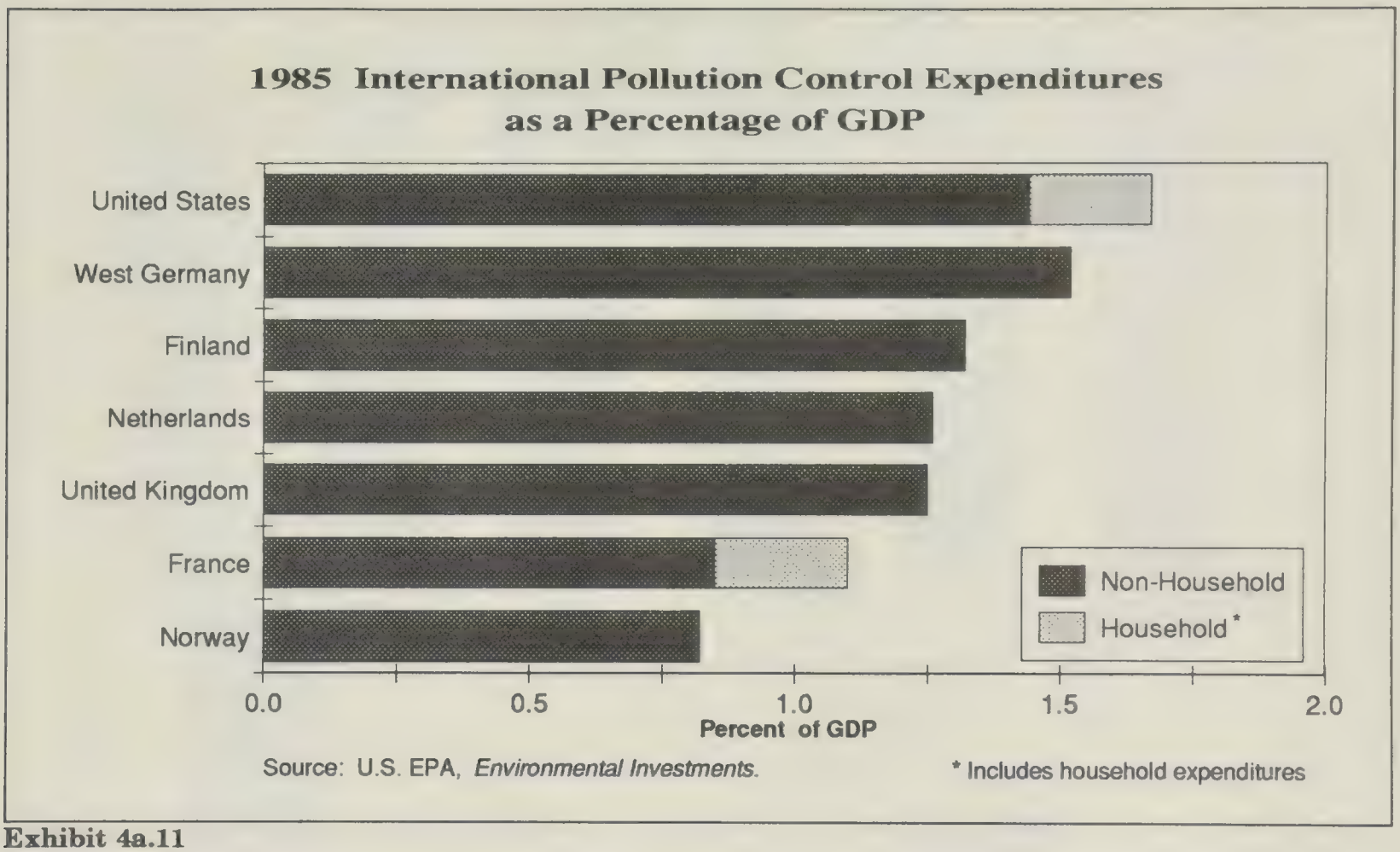


Exhibit 4a.11

Environmental Benefits of Pollution Control

The U.S. government is in the process of developing estimates of the aggregate economic benefits of pollution control comparable to its estimates of the costs of pollution control, but the benefits estimates will not be available for several years. A major difficulty in the estimation of such benefits derives from the fact that damages caused by pollution are not fully reflected in the costs of an unmodified market economy.[5] Consequently, many damages are not directly valued in the marketplace and are more difficult to measure than the costs incurred by individuals and companies in complying with environmental regulations. Measuring economic benefits from the reduction of such damages as a result of pollution control measures is even more difficult to measure accurately.

A necessary condition for quantifying economic benefits from pollution control is that the physical environment improve relative to what it would be in the absence of environmental control programs. With respect to air pollutants, environmental expenditures have resulted in substantial decreases in emissions compared with estimates of what would have been emitted using 1970 technology. This comparison is presented in Exhibit 4a.12 for particulate matter (PM), sulfur dioxide (SO_2), nitrogen oxide (NOx), volatile organic compounds (VOC), carbon monoxide (CO), and lead (Pb). While the reduction in estimated lead emissions is the most dramatic, the actual emissions of nitrogen oxides are only 72 percent of their expected level had the 1970 level of control remained in effect.

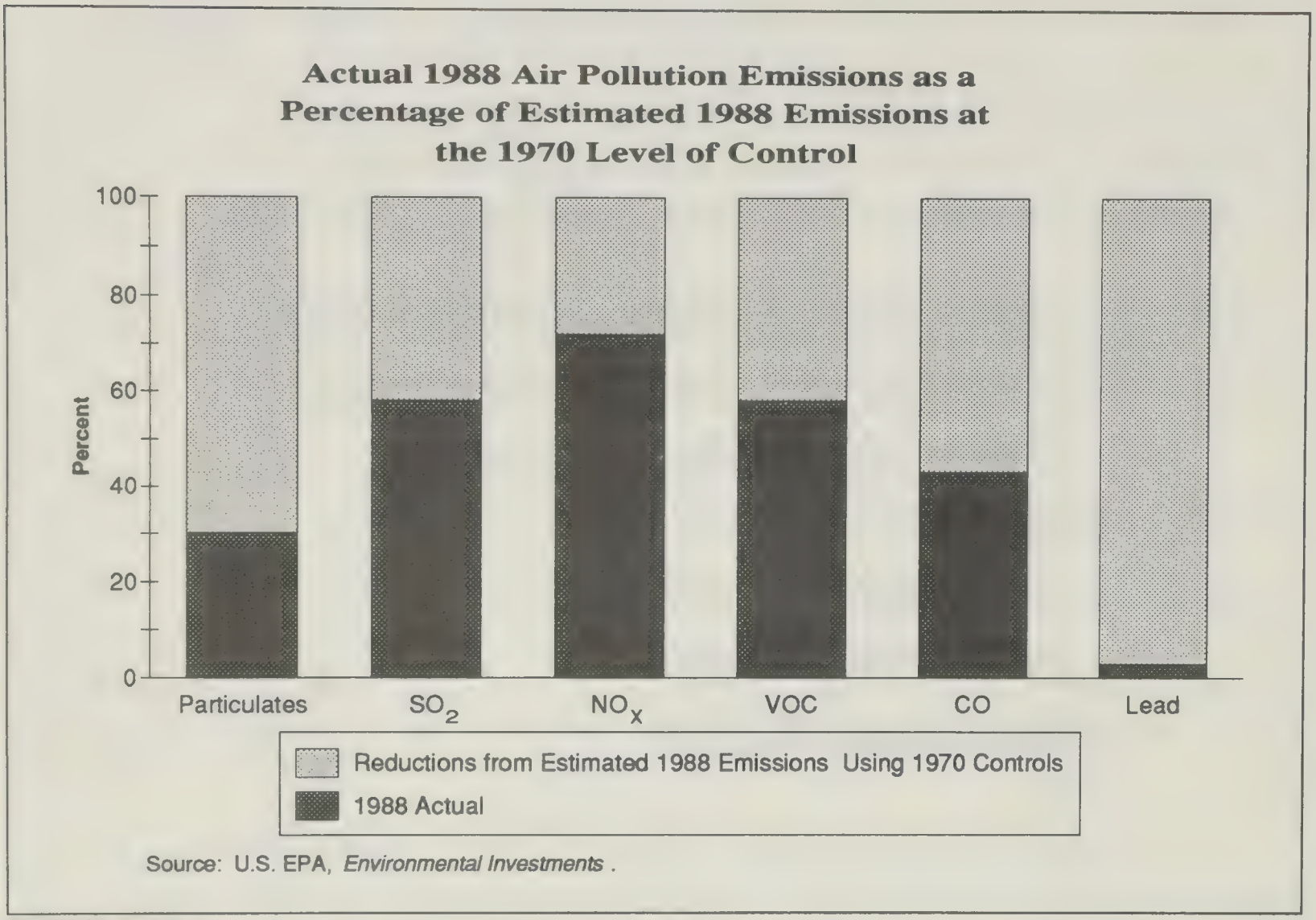


Exhibit 4a.12

A less detailed comparison for two dimensions of water quality compares the actual level of emissions in two different time periods. Such a comparison is displayed in Exhibit 4a.13 for municipal and industrial water discharges for 1973 and the 1980s; it too indicates substantial improvement. Similar comparisons of the time trend of emissions are presented in the freshwater section of this report.

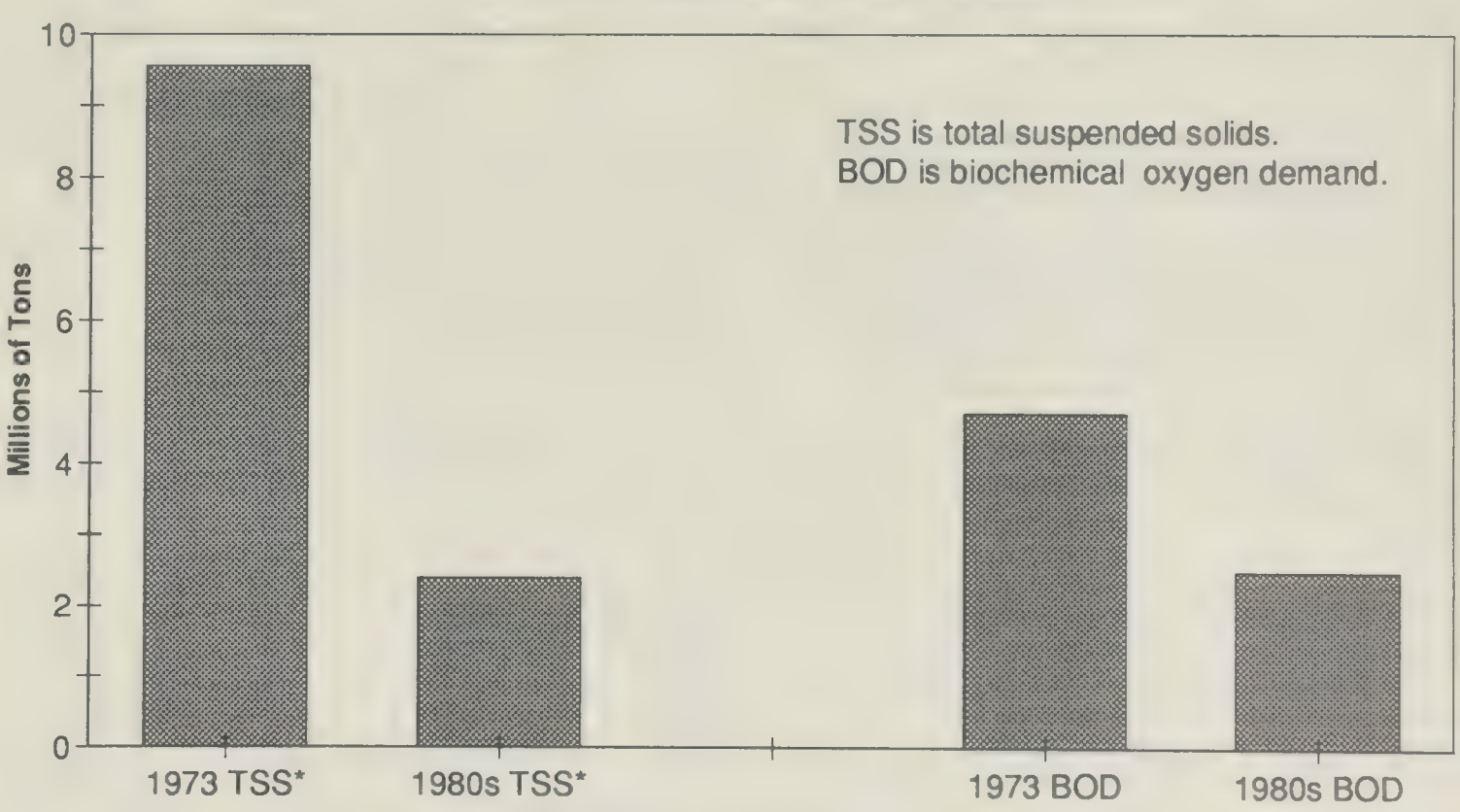
In some policy areas and for some major regulations, measures of the relative benefits and costs have been assessed as required by Executive Order 12291.[6] These include regulations issued under the Clean Air Act, the Clean Water Act and the Toxic Substances Control Act. Some of the changes in policy that have resulted from the application of benefit-cost analysis are: 1) adding new policy alternatives, 2) eliminating alternatives that are not least-cost options, and 3) adjusting alternatives to account for differences between industries or industry segments. In a review of 15 regulations to which

benefit-cost analysis was applied, while over $10 million was spent to conduct such analyses, the regulations studied were associated with over $10 thousand-million in estimated increases in net benefits.

The application of benefit-cost analysis to environmental issues is sometimes hindered by controversial issues in economic analysis—such as the statistical estimation of the value of saving a human life. A more limited form of benefit-cost analysis—cost effectiveness analysis—determines the least cost of achieving a given objective. Information for such an analysis can be based on the cost per estimated life saved (i.e., premature death averted) from pursuing alternative policies. Exhibit 4a.14 presents such data in cost-effectiveness order for a list of major regulations. A substantial variation in the degree of cost-effectiveness is indicated, as the most cost-effective regulation is thousands of times more so than the least cost-effective regulation. Care should be taken to note that most environmental and safety regulations have benefits other than saving lives that are not captured in the cost-effectiveness ratio.[7]

For over a decade, the United States has been working to improve risk-management decision-making by advancing efforts to integrate the processes of risk assessment, estimating the costs of environmental protection, and quantifying the benefits of environmental protection. The United States continues to view international cooperation in this area as important both to improve environmental risk-management approaches in all countries and to work toward globally sustainable development policies and programs.

Municipal and Industrial Water Discharges in 1973 and the Mid-1980s



* 1988 municipal discharges and 1982-1987 industrial discharges.
Source: U.S. EPA, *Environmental Invesments: The Cost of a Clean Environment*, November 1990.

Exhibit 4a.13

RISKS AND COST-EFFECTIVENESS OF SELECTED REGULATIONS

Regulation[1]	Year Issued	Health or Safety	Agency	Baseline Mortality Risk per Million Exposed	Cost per Premature Death Averted ($Millions 1990)
Unvented Space Heater Ban	1980	S	CPSC	1,890	0.1
Aircraft Cabin Fire Protection Standard	1985	S	FAA	5	0.1
Auto Passive Restraint/Seat Belt Standards	1984	S	NHTSA	6,370	0.1
Steering Column Protection Standard[2]	1967	S	NHTSA	385	0.1
Underground Construction Standards[3]	1989	S	OSHA-S	38,700	0.1
Trihalomethane Drinking Water Standards	1979	H	EPA	420	0.2
Aircraft Seat Cushion Flammability Standard	1984	S	FAA	11	0.4
Alcohol and Drug Control Standards[3]	1985	H	FRA	81	0.4
Auto Fuel-System Integrity Standard	1975	S	NHTSA	343	0.4
Standards for Servicing Auto Wheel Rims[3]	1984	S	OSHA-S	630	0.4
Aircraft Floor Emergency Lighting Standard	1984	S	FAA	2	0.6
Concrete & Masonry Construction Standards[3]	1988	S	OSHA-S	630	0.6
Crane Suspended Personnel Platform Standard[3]	1988	S	OSHA-S	81,000	0.7
Passive Restraints for Trucks & Buses (Proposed)	1989	S	NHTSA	6,370	0.7
Side-Impact Standards for Autos (Dynamic)	1990	S	NHTSA	NA	0.8
Children's Sleepwear Flammability Ban[4]	1973	S	CPSC	29	0.8
Auto Side-Door Support Standards	1970	S	NHTSA	2,520	0.8
Low-Altitude Windshear Equipment & Training Standards	1988	S	FAA	NA	1.3
Electrical Equipment Standards (Metal Mines)	1970	S	MSHA	NA	1.4
Trenching and Excavation Standards[3]	1989	S	OSHA-S	14,310	1.5
Traffic Alert and Collision Avoidance (TCAS) Systems	1988	S	FAA	NA	1.5
Hazard Communication Standard[3]	1983	S	OSHA-S	1,800	1.6
Side-Impact Standards for Trucks, Buses and MPVs (Proposed)	1989	S	NHTSA	NA	2.2
Grain-Dust Explosion Prevention Standards[3]	1987	S	OSHA-S	9,450	2.8
Rear Lap/Shoulder Belts for Autos	1989	S	NHTSA	NA	3.2
Standards for Radionuclides in Uranium Mines[3]	1984	H	EPA	6,300	3.4
Benzene NESHAP (Original:Fugitive Emissions)	1984	H	EPA	1,470	3.4
Ethylene Dibromide Drinking Water Standard	1991	H	EPA	NA	5.7
Benzene NESHAP (Revised: Coke By-Products)[3]	1988	H	EPA	NA	6.1
Asbestos Occupational Exposure Limit[3]	1972	H	OSHA-H	3,015	8.3
Benzene Occupational Exposure Limit[3]	1987	H	OSHA-H	39,600	8.9
Electrical Equipment Standards (Coal Mines)[3]	1970	S	MSHA	NA	9.2
Arsenic Emission Standards for Glass Plants	1986	H	EPA	2,660	13.5
Ethylene Oxide Occupational Exposure Limit[3]	1984	H	OSHA-H	1,980	20.5
Arsenic/Copper NESHAP	1986	H	EPA	63,000	23.0
Haz Waste Listing for Petroleum Refining Sludge	1990	H	EPA	210	27.6
Cover/Move Uranium Mill Tailings (Inactive Sites)	1983	H	EPA	30,100	31.7
Benzene NESHAP (Revised: Transfer Operations)	1990	H	EPA	NA	32.9
Cover/Move Uranium Mill Tailings (Active Sites)	1983	H	EPA	30,100	45.0
Acrylonitrile Occupational Exposure Limit[3]	1978	H	OSHA-H	42,300	51.5
Coke Ovens Occupational Exposure Limit[3]	1976	H	OSHA-H	7,200	63.5
Lockout/Tagout[3]	1989	S	OSHA-S	4	70.9
Asbestos Occupational Exposure Limit[3]	1986	H	OSHA-H	3,015	74.0
Arsenic Occupational Exposure Limit[3]	1978	H	OSHA-H	14,800	106.9
Asbestos Ban	1989	H	EPA	NA	110.7
Diethylstilbestrol (DES) Cattlefeed Ban	1979	H	FDA	22	124.8
Benzene NESHAP (Revised: Waste Operations)	1990	H	EPA	NA	168.2
1.2-Dichloropropane Drinking Water Standard	1991	H	EPA	NA	653.0
Haz Waste Land Disposal Ban (1st 3rd)	1988	H	EPA	2	4,190.4
Municipal Solid Waste Landfill Standards (Proposed)	1988	H	EPA	<1	19,107.0
Formaldehyde Occupational Exposure Limit[3]	1987	H	OSHA-H	31	86,201.8
Atrazine/Alachlor Drinking Water Standard	1991	H	EPA	NA	92,069.7
Haz Waste Listing for Wood Preserving Chemicals	1990	H	EPA	<1	5,700,000.0

[1] 70-year lifetime exposure assumed unless otherwise specified. [2] 50-year lifetime exposure.
[3] 45-year lifetime exposure. [4] 12-year lifetime exposure. NA=Not available.

Agency Abbreviations—CPSC: Consumer Product Safety Commission; MSHA: Mine Safety and Health Administration; EPA: Environmental Protection Agency; NHTSA: National Highway Traffic Safety Administration; FAA: Federal Aviation Administration; FRA: Federal Railroad Administration; FDA: Food and Drug Administration; OSHA-H: Occupational Safety and Health Administration, Health Standards; OSHA-S: Occupational Safety and Health Administration, Safety Standards.

Source: John F. Morrall, III. "A Review of the Record," *Regulation*, Vol. 10, No. 2 (1986), p.30. Updated by the Author, *et.al.*

Exhibit 4a.14

BENEFIT-COST ANALYSIS—TWO EXAMPLES

Benefit-cost analysis was applied to the phaseout of lead in gasoline. Over an eight-year period, estimates indicated that the cost of the lead phaseout to refiners would be about $3.6 thousand-million. The quantifiable benefits, on the other hand, added up to more than $50 thousand-million, including nearly $42 thousand-million in medical costs avoided for both children and adults, $1.6 thousand-million in pollution-related environmental damage avoided, and nearly $5.8 thousand-million in lower vehicle maintenance costs.

Different results were obtained when benefit-cost analysis was applied to proposed effluent guidelines for the organic chemicals, plastic resins and synthetic fibers industries. The study indicated that the quantifiable benefits, including recreation benefits, non-user benefits, health benefits, diversionary uses and commercial fishing benefits, might range between $2.3 and $9.7 million (in 1982) for a case study on a river area in West Virginia, but might be as low as $1 million for an industrialized waterway in the Gulf Coast region. The costs of implementing the proposed guidelines were estimated to be $5.8 million for the West Virginia case and $25 million for the Gulf Coast case. These estimates illustrate the importance of specifying the geographic area in any economic evaluation of a proposed environmental improvement.

Source: EPA's Use of Benefit-Cost Analysis: 1981-1986 (Note 6)

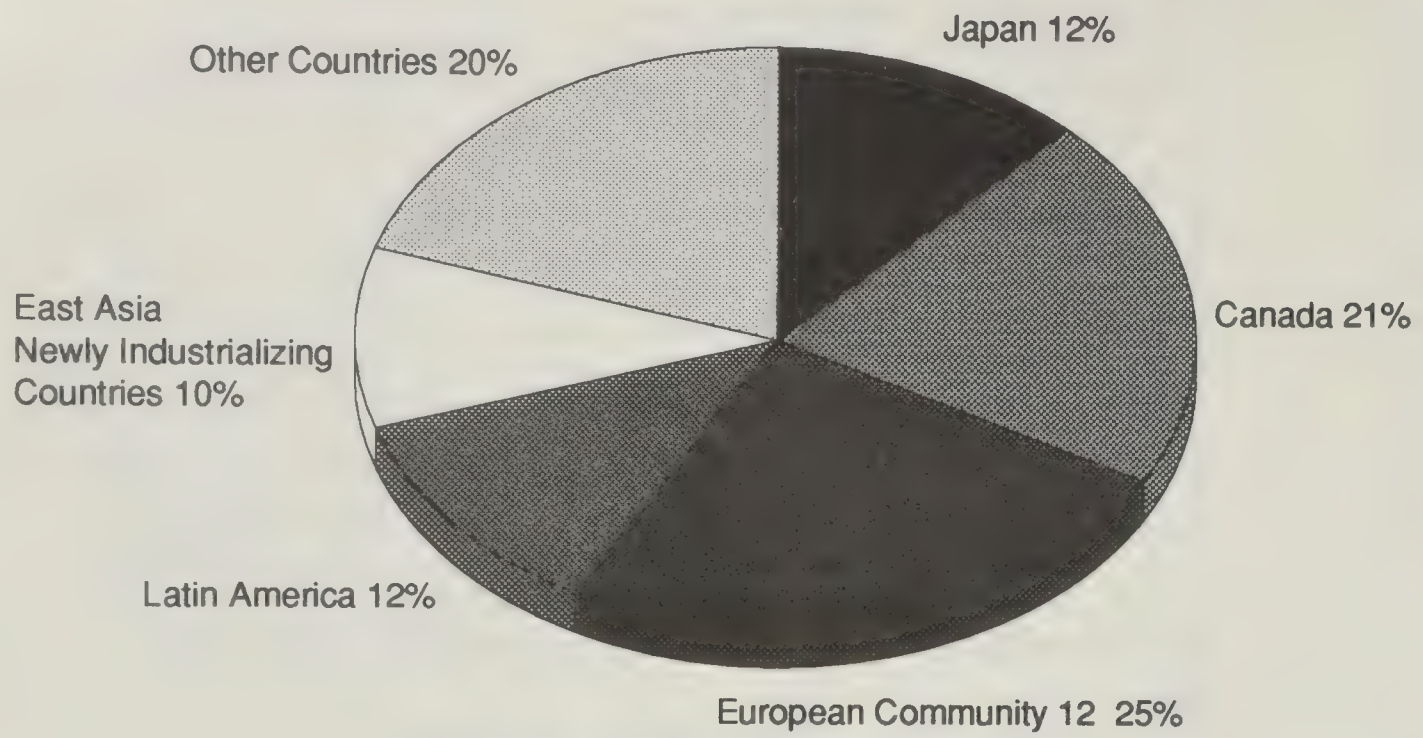
International Trade

International trade, a vital component of U.S. economic development, has many environmental implications. For most of the past 20 years, trade and environmental protection have existed as separate, discrete policy areas with little interaction between them. This section discusses the statistical background of U.S. trade and emerging issues that link trade, trade institutions and the environment.

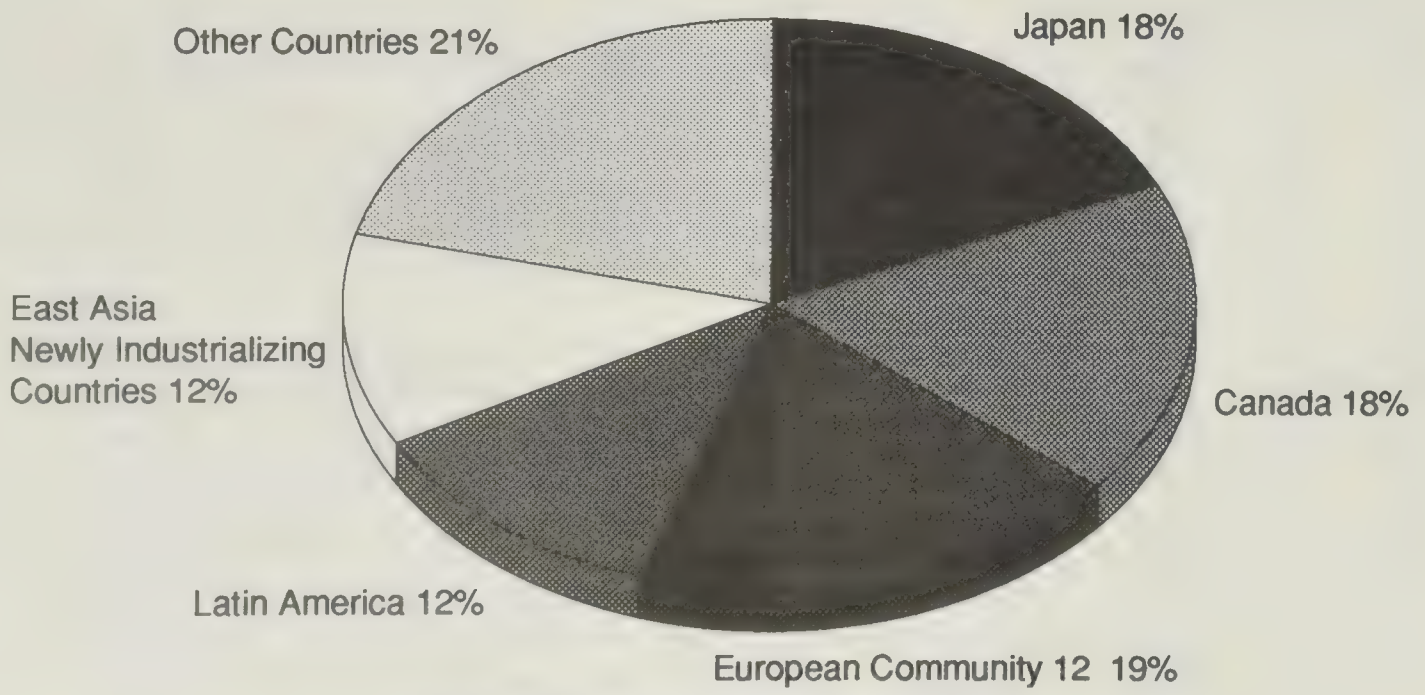
Trade and Emerging Issues

The United States conducts trade with virtually all other countries of the world. Six major trading areas are represented in Exhibit 4a.15; the European Community (EC) is the largest trading group. The largest export markets for the United States are Canada, Japan, Mexico, the United Kingdom and Germany. The composition of U.S. merchandise trade with the world is presented in Exhibit 4a.16.[8] The major share of U.S. exports and imports merchandise are manufactured goods. Crude materials, largely petroleum and petroleum products, represent 16 percent of the value of merchandise imports. The overall merchandise trade deficit of $101 thousand-million in 1990 is partially compensated for by a surplus in the service account.[9] For 1990, merchandise (excluding military merchandise) accounted for 60 percent of U.S. exports of goods, services and income, with services (including travel, transportation and royalty and license fees) contributing 20 percent. Income received on U.S. assets abroad accounted for 20 percent of exports and income. U.S. imports of goods, services and income were composed of merchandise, representing 67 percent of the total; services, 14 percent; income payments on foreign assets, 16 percent; and unilateral transfers, including government grants, three percent.

The Direction of U.S. Merchandise Trade, 1990



Exports: $394 Thousand-Million

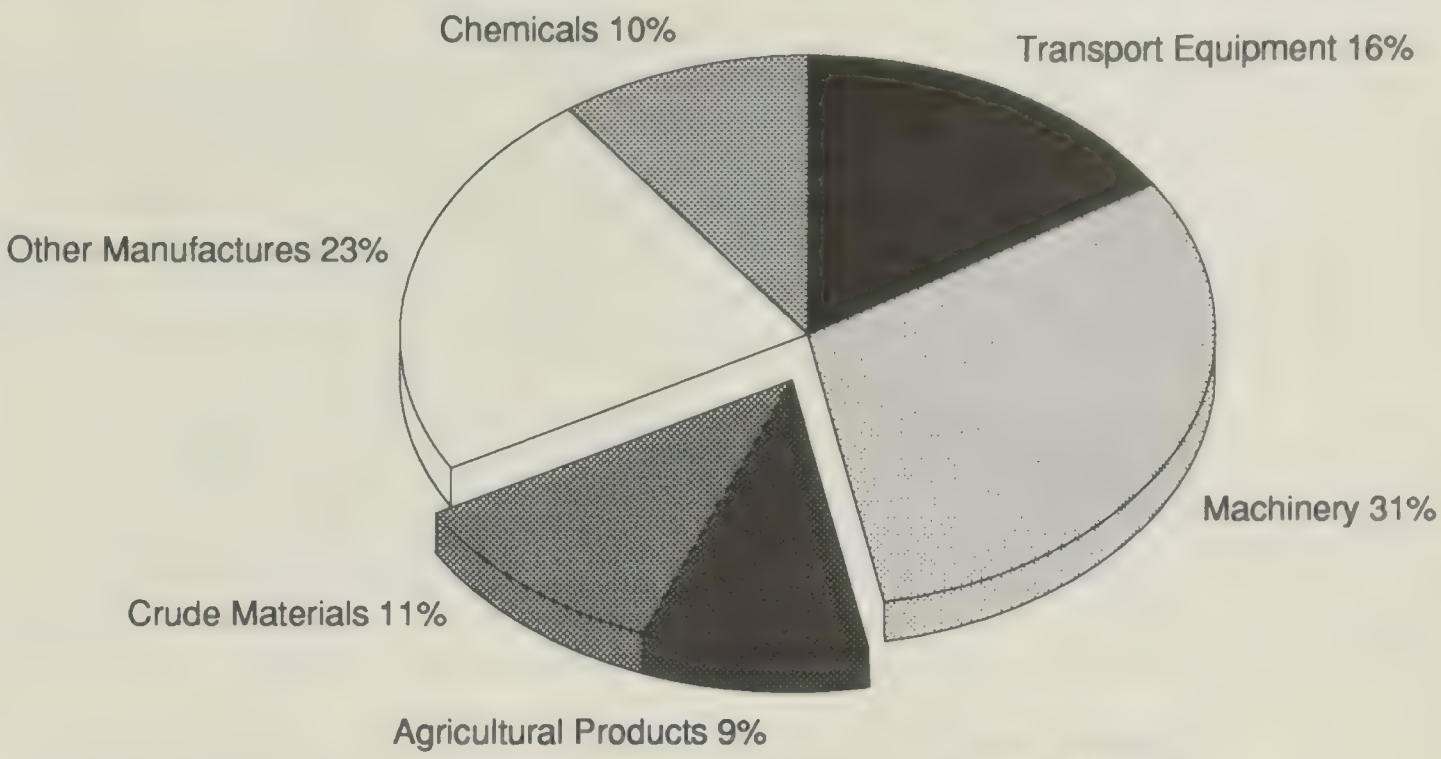


Imports: $495 Thousand-Million

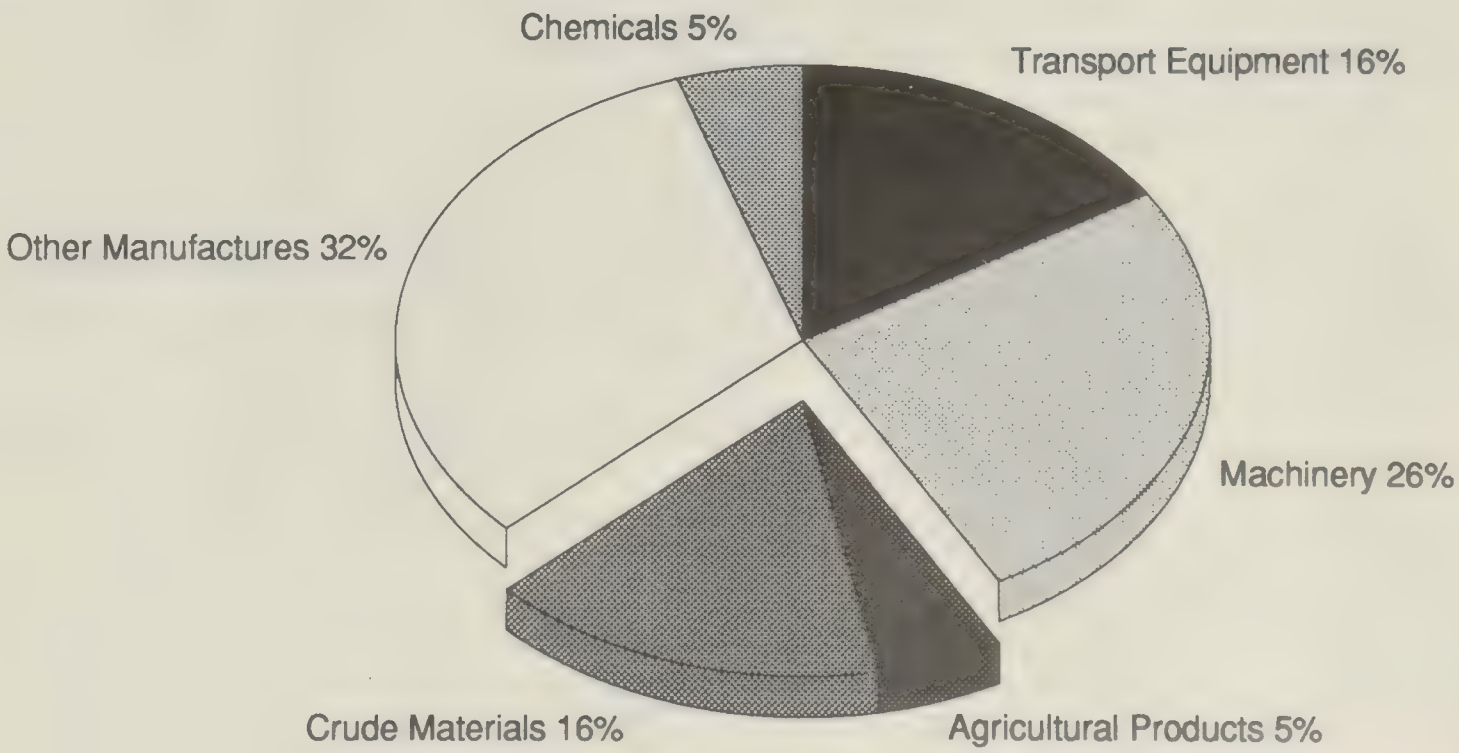
Source: Bureau of the Census, Economics and Statistics Administration, U.S. Department of Commerce.

Exhibit 4a.15

The Composition of U.S. Merchandise Trade, 1990



Exports: $394 Thousand-Million



Imports: $495 Thousand-Million

Source: Bureau of the Census, Economics and Statistics Administration, U.S. Department of Commerce.

Exhibit 4a.16

The interaction of international trade and the environment is receiving increasing attention from the federal government, from U.S. industries and citizens' organizations, and from international organizations. Many questions are being raised relating to the economic effects of environmental controls on competitiveness and the environmental effects of trade policies. The following four areas of inquiry represent some of the emerging issues that integrate trade and the environment:

- Although domestic environmental regulations have increased the cost of production, there is evidence that the competitive effects of environmental policy may not be very serious and in fact may be positive overall. The primary reason is that the costs of pollution control have not been very large in proportion to total production costs, even in heavily polluting industries in countries with stringent pollution control policies. In addition, international comparisons of environmental regulations show that many of the industrialized countries have introduced similar environmental measures, at roughly the same time, so that such measures have not been the source of significant cost differentials among major competitors.[10] However, many U.S. firms remain concerned that, particularly in the case of basic industrial products with mature markets and established technology, environmental costs could adversely affect international competitiveness vis-a-vis firms operating in countries where environmental regulation is much less of a cost factor.

- Direct effects of trade on the environment have been the subject of increasing debate. In part, trade and environmental policies determine where commodities will be produced and in what quantities. There is concern about the relocation of industries to jurisdictions with less strict controls (so-called "pollution havens"). Since the production of some commodities is inherently more environmentally damaging than others, the patterns of international trade can affect local environmental quality.

- Concern within the United States over environmental quality, health and safety has led to the promulgation of regulatory standards for products consumed domestically. Such product standards generally apply to imports as well as domestically produced commodities. This may lead, for example, to a ban on the importation of products that contain proscribed substances at certain levels or that generate an excessive level of pollutants when used.

- Concern is growing over the interactions between the export of domestically banned substances (such as certain pesticides and food additives) and the possible consequent import of products that contain trace substances.

Trade Agreements and Institutions

Throughout the last 20 years, the United States has enacted a number of domestic laws and ratified several international agreements which meet a range of policy objectives including those affecting environmental issues. Examples include portions of the Endangered Species Act, the Resource Conservation and Recovery Act, the Marine Mammal Protection Act, the Montreal Protocol on Substances that Deplete the Ozone Layer and others surveyed in more detail in the chapter on environmental law.

In the early 1990s, however, the trade and environmental communities in the United States have engaged in an increasing dialogue to integrate trade and environmental considerations into the policy forum. For instance, the decision to launch negotiations for a North America Free Trade Area (NAFTA) sparked considerable interest among U.S. environmental groups, leading to their active participation in the process.[11] In connection with this debate,

the United States prepared an environmental review of the NAFTA and established environmental commitments with respect to the NAFTA process.

The United States has also supported the efforts of international organizations to address emerging issues involving trade and the environment. In the Organization for Economic Cooperation and Development (OECD), the United States strongly supported a recommendation to establish a joint experts group to report on how to protect the environment and preserve the open multilateral system. Within the General Agreement on Tariffs and Trade (GATT), the United States was a key proponent in the successful efforts to reconstitute the trade and environment working group, favoring a broad mandate for that group. The GATT has always allowed for contracting parties to take trade-limiting measures as a means of protecting human, animal, and plant health and safety within their jurisdiction, but many of the new issues address subtle ties between internal environmental policies, trade issues and protection of the global environment that are still to be resolved.

Many of the above interactions between trade and the environment are indirect and difficult to observe. Others are more direct. Two specific issues relating to these topics are presented in this chapter as case studies: the Convention on International Trade in Endangered Species (CITES) and the Basel Convention on the Transboundary Movement of Hazardous Wastes.

CASE STUDY

TRADE IN HAZARDOUS WASTE

Concern about waste dumping in developing countries led to the Basel Convention on Control of Transboundary Movements of Hazardous Wastes and Their Disposal (1989), now signed by 56 countries, including the United States. The Convention contains 29 articles that govern the export for disposal and recycling of hazardous wastes and other wastes. Under proposed U.S. legislation for implementing the Basel Convention, export of hazardous and certain other wastes from the United States would be permissible only if the recipient country had executed an appropriate bilateral agreement with the United States.

International trade in waste for disposal and recycling, especially hazardous waste, is a relatively recent concern. Approximately 270 million metric tons of hazardous waste are generated in the United States each year. (See Chapter 6 on wastes). Approximately 0.14 million tons of hazardous wastes were exported from the United States in 1990 with Canada receiving almost 68 percent of the waste and Mexico receiving 28 percent.

CASE STUDY

TRADE IN WILDLIFE PRODUCTS

The regulation of trade in wildlife products serves as an example of how environmental regulations can directly affect trade. The international trade in endangered plants and animals has been regulated since the mid-1970s by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The regulation takes the form of a ban on commercial trade in endangered species and the regulation of trade in species that might become endangered. The U.S. trade in wildlife, both imports and exports, is approximately $1 thousand-million annually. Exhibit 4a.17 lists quantities and declared values of U.S. imports of wildlife for major categories of permissible trade regulated by CITES.

U.S. IMPORTS OF WILDLIFE IN A TYPICAL YEAR

Primates	16,000 - 18,000 live animals (mostly for research); Declared value: $2-2.5 million
Furs	6 million skins; Declared value: $800 million
Ivory	Trade banned in 1989. {Prior years: 5-6 million carved products, 5,000 raw ivory tusks; Declared value: $25-30 million}
Birds	800,000 live (about 250,000 parrots); Declared value: $15 million
Reptiles	1.2 million live, 1.5 million skins, 30 million manufactured products; Declared value: $300 million
Ornamental fish	125 million live animals; Declared value: $25-30 million
Shells	12-15 million raw shells, 50 million manufactured products; Declared value: $12-13 million
Corals	1,000-1,500 tons of raw corals, 2-3 million manufactured products; Declared value: $5-6 million

Source: Department of Interior, Fish and Wildlife Service, Office of Management Authority.

Exhibit 4a.17

International Assistance and Debt

International assistance programs of the United States and U.S. holdings of international debt affect both domestic and international efforts to integrate development and environment concerns. The United States has provided overseas economic assistance programs, both bilaterally and through multilateral organizations, for over 40 years. The mission and goals of this assistance have evolved during that period to meet changing needs and different perceptions about the best way to support development and also to improve environmental quality. Exhibit 4a.18 indicates the annual trend in U.S. international assistance, which has been relatively stable in constant dollar terms between $7 and $9 thousand-million (1982).[12] In all, total U.S. international economic assistance from 1972 through 1991 channeled through the Agency for International Development (A.I.D.), the State Department, the Peace Corps, the Overseas Private Investment Corporation, the Export-Import Bank, the

Food for Peace Program, contributions to multilateral lending institutions, the United Nations, and other organizations, totaled $155 thousand-million in nominal dollars.

TOTAL U.S. NON-MILITARY ECONOMIC ASSISTANCE

Fiscal Year	Thousand-million Current Dollars	Thousand-million Constant 1982 Dollars
1972	3.94	8.47
1973	4.11	8.32
1974	3.91	7.23
1975	4.91	8.28
1976	3.88	6.09
1977	5.59	8.31
1978	6.66	9.23
1979	7.12	9.06
1980	7.57	8.84
1981	7.30	7.77
1982	8.13	8.13
1983	8.60	8.28
1984	9.04	8.39
1985	12.33	11.12
1986	10.79	9.48
1987	9.39	7.99
1988	8.96	7.39
1989	9.86	7.81
1990	10.24	7.78
1991	10.30	7.46*

*Preliminary
Source: U.S. Agency for International Development

Exhibit 4a.18

For fiscal year 1991, the major categories of environment and development assistance are presented in Exhibit 4.19.[13] A.I.D. manages over 70 percent of these funds, including portions of the Public Law 480 (Food for Peace) program. Payback provisions for AID assistance have changed over the 20-year period. There has been a gradual trend away from concessional loans for lower-income countries and towards grants, technical assistance and other projects not likely to generate profits. An all-grant program for all A.I.D. recipients (for new activities) was authorized by Congress in 1989. Repayment criteria apply to different portions of the Food for Peace program, ranging from full repayment to outright grants.

The use of economic assistance has changed over time. In 1972, at the time of the Stockholm Conference, the programmatic emphasis of U.S. assistance was shifting from financial assistance for large investments in plant and equipment to programs for meeting basic human needs, especially for the rural populations of developing countries. Today, attacking poverty continues to be a major goal and purpose of U.S. economic assistance through ongoing programs designed to:

U.S. INTERNATIONAL ASSISTANCE, FY 1991
Current dollars, thousand-millions

A.I.D. Economic Assistance	$6.412
(environmental assistance, $.6)	
Other Bilateral Assistance	.974
Multilateral Assistance	1.904
Public Law 480 (Food for Peace)	1.082
Total Economic Assistance	**10.372**

Source: U.S. Agency for International Development.

Exhibit 4a.19

- support agricultural systems that are productive, sustainable and environmentally sound, and that increase incomes, especially in the private sector;

- improve primary and other health services, including child survival, and AIDS prevention and control;

- provide population assistance, including contraceptives, expanded access to services, training of family planning personnel and technical assistance in implementing population policies; and

- strengthen basic education through education policy reforms and targeted assistance to support needed technical and administrative changes.

In the environmental arena, the United States supports programs of assistance related to forestry, energy, oceans, climate change, biodiversity, sustainable agriculture and effects of environmental health hazards. The following programs are examples of current foreign aid activities that integrate environment and development concerns:

- improvement of public health through water and sanitation projects. An existing long-term effort to provide economic, engineering and health services is being expanded to include new initiatives on environmental quality management and planning.

- inventories that help developing countries to assess their environment and natural resources base, put natural resource data to better use in the planning process and identify those policies that affect natural resource use.

- land tenure projects that address issues of common property in natural forest and grazing management, and the effect of tenure insecurity and agrarian structure on sustainable natural resource use and technology adoption.

- initiatives related to debt-for-nature, debt-for-science, debt-for-equity, and debt-for-development swaps, using debt obligations held by U.S. government or private banking institutions. These swaps involve retiring discounted debt in exchange for developmental or environmental

investments in the debtor country, such as conservation projects or designation of park lands.

- support for the newly created Global Environmental Facility administered by the World Bank.

- technology cooperation, specifically to improve the process for successful introduction and adaption of technologies involving a complex set of environmental resources and skills, including hardware, experience, training, operational and maintenance capability, strategic planning, environmental assessment and decision-making, and integrated designs.

International Debt

Heavy debt burdens can inhibit broad-based economic growth and new environmental initiatives. U.S. policy is directed at helping debt-distressed countries undertake economic reforms to promote growth and to restore credit-worthiness in the medium and long term. In addition to direct financial assistance, the U.S. government has provided debt service rescheduling and, in some cases, debt reduction.

The worldwide debt of the developing nations exceeded a million-million dollars in 1990. As many of those nations became less able to service their debt during the 1980s, the United States and other creditors responded with an international debt strategy which stressed a case-by-case approach to the circumstances of individual debtors. Exhibit 4a.20 lists the U.S. commercial bank claims on highly indebted countries as reported by banks.

Claims reported by U.S. banks on highly indebted countries, recorded in the U.S. balance of payments, peaked in the 1983-84 period after rapid growth in the 1970s and early 1980s. By 1990 those debts had decreased by nearly half from their peak levels, as banks confronted heightened risk, debtor nonpayment, and U.S. regulatory and supervisory changes.

The Brady Plan, announced in March 1989, called for commercial bank debt-service reduction as a complement to new lending in debt restructuring agreements. Mexico, the Philippines, Costa Rica, Chile, Venezuela, Uruguay, Morocco and Nigeria reached such agreements as of mid-1991. These agreements have helped sustain and extend the market-oriented economic reforms encouraged by the "Baker Plan," introduced in 1985.

The United States is also taking action to ease official debt burdens for countries undertaking economic reforms. On a multilateral basis the U.S. has agreed to more generous terms on debt reschedulings for both the poorest and the lower middle-income countries. The United States participated in the exceptional debt reduction provided to Egypt and Poland. In the case of Poland, the U.S. agreed to debt reduction that went beyond the multilateral consensus, including an additional 10-percent reduction to enable Poland to establish a Polish Environmental Foundation. Bilaterally, the United States has forgiven concessional debts owed by least developed countries following International Monetary Fund (IMF) or World Bank adjustment programs. The United States has forgiven A.I.D. debt owed by 20 countries, and Public Law 480 debt owed by 12 countries.

The United States has also introduced the Enterprise for the Americas Initiative (EAI) to enhance growth throughout the Western Hemisphere. The EAI is designed to increase free trade, open investment, ease debt burdens, improve the environment and promote private capital flows. It is intended to reduce official non-military debts to the U.S. government of countries that are undertaking macroeconomic and structural reforms through IMF programs, are liberalizing their trade and investment regimes, and have concluded agreements with commercial creditors as appropriate. EAI offers potential debt reduction on the $12 thousand-million of the U.S. government's share of

DEBT-FOR-NATURE SWAPS

In 1987, an American non-profit organization, Conservation International, initiated the process now commonly called a "debt-for-nature swap," which combines debt policy and environmental policy. In general, a debt swap often involves a third party, usually a nongovernmental organization, acquiring from foreign banks a developing country's hard currency debt—often at a discount—and subsequently exchanging it with the debtor country government for local currency funds to finance development, public health or environmental conservation projects. The first debt swap involved exchanging U.S.-held debt for a commitment from the Bolivian government to pay for the operating costs of the Beni Biosphere Reserve in northeastern Bolivia. In 1989, the U.S. Agency for International Development (A.I.D.) determined that under existing legislation, A.I.D. funds could be used by a grantee to purchase discounted external debt and exchange it for local currency to carry out a project. A.I.D. funded four debt swaps through 1990, and completion of six additional swaps, totaling $30 million, was pending in 1991.

While debt-for-nature swaps have been the most visible type of debt conversion, debt swaps can be used to raise local currency for virtually any type of development activity. For example, a debt-for-human resources swap involved the International Foundation for Education and Self Help in supporting programs in Niger, Guinea and Nigeria.

Source: Conservation International, "The Debt-for-Nature Exchange," 1991 Update; and the Agency for International Development.

the regions's $340 thousand-million long-term debt. When concessional debt is reduced, the EAI will permit interest payments on the reduced debt to be paid in local currency and channeled into local environmental funds for uses identified by local environmental councils composed of local non-government organizations, host governments and U.S. government representatives. The EAI also makes provision for debt swaps to reduce non-concessional Export-Import Bank and Commodity Credit Corporation credit.

Technology Transfer and Cooperation

Technological change is known to be a central process in the dynamics of economic development and indirectly affects many dimensions of environmental quality. The actual process of technological change goes through several stages—from basic research and development, to applied research and development, to technological adoption and diffusion. Although technology transfer is directly associated with issues and mechanisms of adoption and diffusion, it builds upon the institutions and incentives for basic and applied research.

The federal government funds approximately 50 percent of all U.S. research and development, although industry performs almost three-quarters of the total research and development (see Exhibit 4a.21). A large part of the federally supported research and development is related to defense. Exhibit 4a.22 indicates the total U.S. spending on research and development, its size relative to GNP and its breakdown between defense and non-defense spending. Expenditures on research and development have remained fairly steady, at approximately 2.5 percent of GNP for total expenditures and approximately 1.7 percent for non-defense expenditures.

Among the important federal institutions performing research and development are the Department of Defense, the National Energy

U.S. CLAIMS ON HIGHLY INDEBTED COUNTRIES REPORTED BY BANKS IN THE UNITED STATES

Millions of Current Dollars

High-debt countries	1978	1980	1982	1984	1986	1988	1990
Argentina	2,472	6,075	11,257	11,225	12,495	12,322	7,414
Brazil	6,698	11,085	24,153	26,745	26,086	26,348	18,771
Chile	1,064	2,030	5,604	7,011	6,656	5,466	3,538
Colombia	1,068	1,817	3,294	3,583	2,967	3,146	2,715
Ecuador	774	1,261	2,149	2,469	2,537	2,210	1,479
Jamaica	48	44	199	268	207	220	242
Mexico	5,707	12,942	30,125	35,186	31,367	26,852	15,793
Morocco	108	257	392	604	624	525	682
Panama	3,148	5,803	10,477	7,786	5,746	2,787	1,708
Peru	935	940	2,427	2,411	1,689	1,036	698
Philippines	726	1,051	2,681	2,589	2,234	1,897	1,247
Uruguay	67	173	713	1,104	962	947	807
Venezuela	3,889	5,796	10,991	11,225	11,193	11,050	2,909
Yugoslavia	446	924	1,530	1,905	1,909	1,418	1,161
TOTALS	**27,150**	**50,198**	**105,992**	**114,111**	**106,672**	**96,224**	**59,164**

Source: Bureau of Economic Analysis, Economics and Statistics Administration, U.S. Department of Commerce.

Exhibit 4a.20

U.S. R&D FUNDERS AND PERFORMERS: 1989
(Millions of dollars)

	Funders	%	Performers	%
Industry	64,035	48	95,350	72
Federal Government	62,700	47	14,750	11
Universities & Colleges	3,800	3	13,900	11
Federally Funded R&D Centers	—	—	4,650	4
Nonprofits	1,815	1	3,700	3
Totals	**132,350**	**100**	**132,350**	**100**

Source: National Science Board, *Science and Engineering Indicators—1989*, NSB 89-1, U.S. Government Printing Office, Washington, D.C., 1989.

Exhibit 4a.21

Laboratories, the National Institutes of Health, the National Aeronautics and Space Administration, the Agricultural Research Service and the Cooperative State Research Service, the U.S. Geological Survey, the Environmental Protection Agency and the National Oceanic and Atmospheric Administration.

The institutions and principles that foster technological change in the United States are well-established. The U.S. Constitution gives Congress the power "to promote the progress of science and useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries." Abraham Lincoln emphasized the importance of

U.S. RESEARCH AND DEVELOPMENT EXPENDITURES
(Thousand-millions of 1982 dollars)

Year	R&D	R&D % of GNP	Non-defense R&D	Non-defense R&D % of GNP
1971	60.4	2.4	42.1	1.7
1972	61.4	2.3	42.3	1.6
1973	62.4	2.3	44.3	1.6
1974	61.5	2.2	44.8	1.6
1975	59.9	2.2	43.6	1.6
1976	62.1	2.2	45.6	1.6
1977	63.7	2.1	46.0	1.6
1978	66.8	2.1	48.9	1.6
1979	70.1	2.2	52.5	1.6
1980	73.2	2.3	55.8	1.7
1981	76.6	2.4	57.0	1.8
1982	79.4	2.5	57.3	1.8
1983	84.0	2.6	60.0	1.8
1984	90.7	2.6	63.5	1.8
1985	97.0	2.7	66.6	1.8
1986	98.6	2.7	66.2	1.8
1987	100.8	2.6	67.5	1.8

Source: National Science Board, *Science and Engineering Indicators* 1989—NSB 89-1, U.S. Government Printing Office, Washington, D.C., 1989.

Exhibit 4a.22

private rights to inventions in 1859, stating,"The patent system added the fuel of interest to the fire of genius."[14]

However, while privately funded research could be patented (protected from uncompensated duplication or adoption for a fixed period of time), federally funded research, such as that performed by universities, private contractors, and federal laboratories, could not be privately patented until reforms in federal laws were made in 1980 and 1986. These reforms have substantially increased the flow of inventions from federally funded activity into patents and potential commercialization. Universities increased their patenting activity by almost 500 percent between 1978 and 1989, and federal royalty income quadrupled between 1985 and 1988, though it remained at a low level relative to university royalties.[15]

The adoption and diffusion of technologies typically depends on the private decisions of consumers and companies, although environmental and safety regulations have influenced the adoption of some types of technology. Research indicates that there are many determinants of technological adoption, including private profitability, technological complexity and the technical capacity of the adopter.

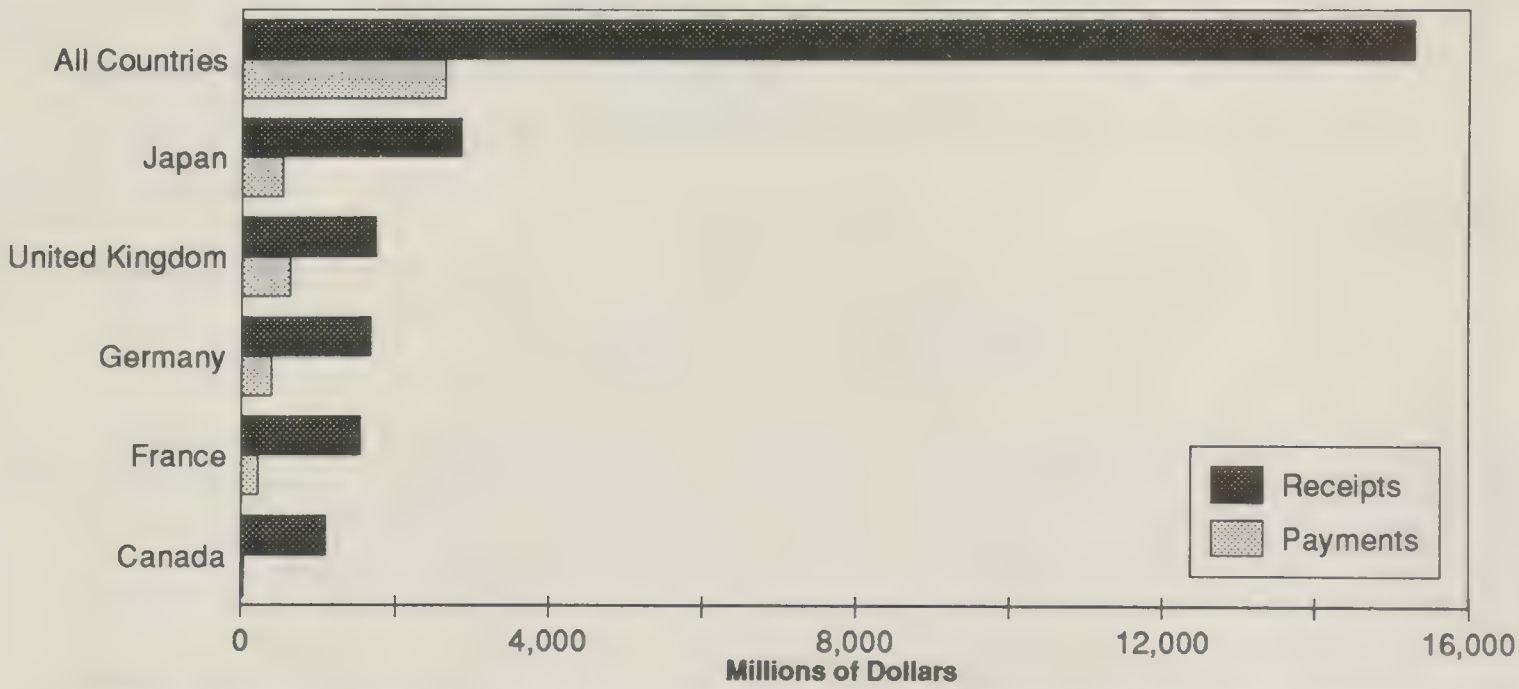
International Technology Transfer

In the international arena, the United States pursues policies consistent with our internal policies. These include free markets and free international trade as the major agents for adaptation and diffusion of environmentally sound technologies, especially for commercially applied technologies. Adaptation and subsequent diffusion of technology occurs principally as the result of exports of goods and services, direct foreign investment, joint ventures and licensing. Technology has been adapted most successfully in those countries where the

business environment encourages such adaptation, such as countries that offer adequate protection for intellectual property, as well as relative ease in establishing and operating businesses and in repatriating profits.

Governments and international institutions are seen as playing a supplemental, though significant, role as clearing houses for information and technical assistance on specific technologies and their appropriate uses. To that end, their efforts to refocus existing resources and institutional efforts can improve the flow of technical information and assistance on environmentally sound technologies to developing countries. The adaptation and diffusion of technology may be aided by foreign assistance from developed to developing countries, either by governments directly or through multilateral institutions. International trade data contain indicators of the extent of technology transfer between countries. Data on fees received and paid for licenses and royalties reflect financial agreements that can transfer technology. Data on the balance of royalties and fees paid for 1990, shown in Exhibit 4a.23, indicate larger receipts than payments for Japan, Germany, the United Kingdom, Canada, France and for the countries not named.

U.S. Receipts and Payments of Royalties and Fees Associated with Foreign Residents, by Country: 1990

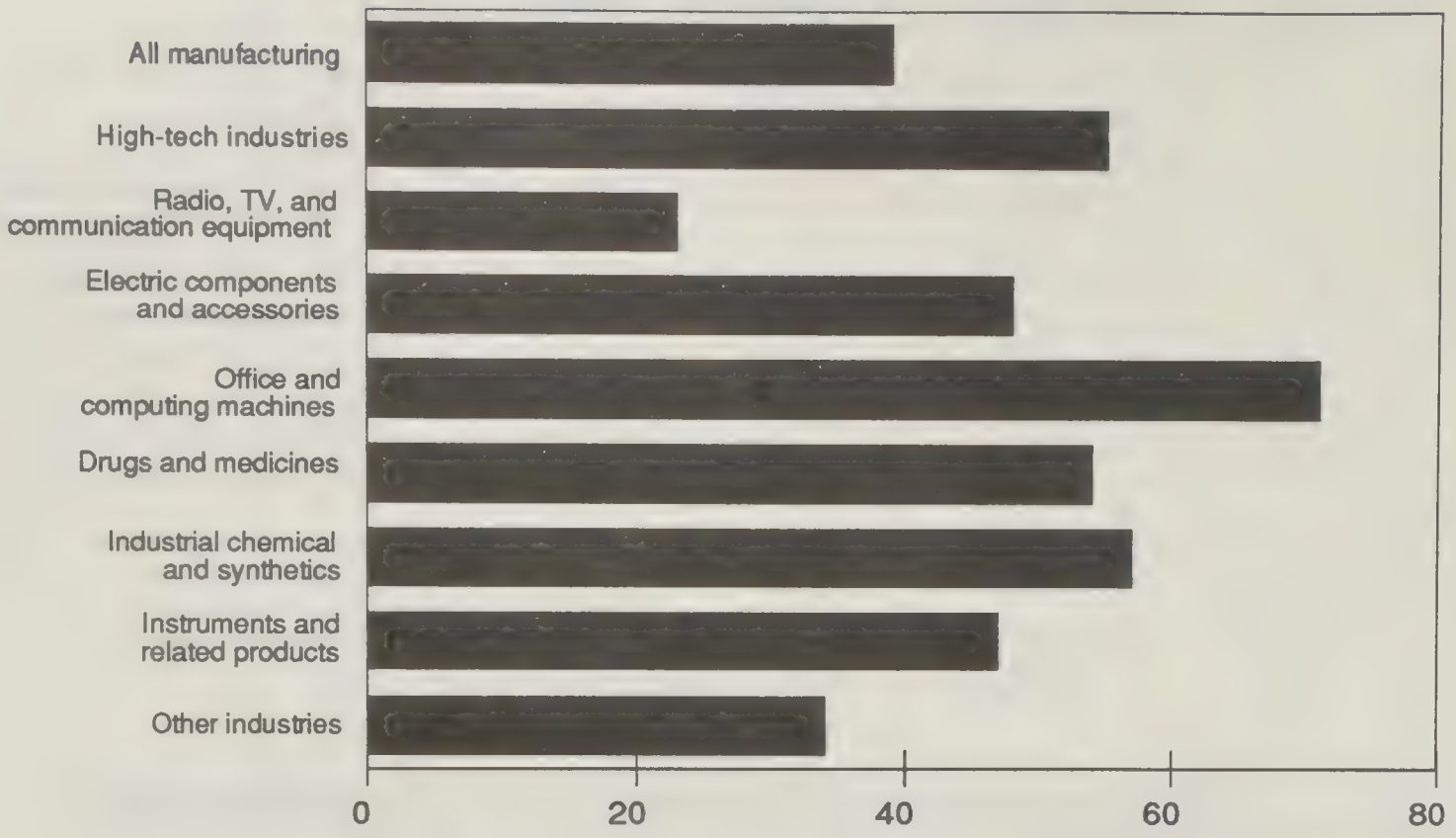


Source: Bureau of Economic Analysis, Economics and Statistics Administration, U.S. Department of Commerce.

Exhibit 4a.23

While international trade statistics account for the flow of goods and services among nations, direct investment by domestic businesses in foreign countries is also an important mechanism for the transfer of technology, both to and from the foreign country. Exhibit 4a.24 shows the percent of the assets of U.S. corporations that are invested in foreign countries, with particular attention to high-technology manufacturing industries. The share of total assets invested in foreign countries ranges from a low of 23 percent in the radio, TV and communications equipment industry to a high of 71 percent in the office and computing machine industry.

Total Foreign Assets of U.S. Corporations as a Percentage of Total Assets: 1988



Source: Based on data from Bureau of Economic Analysis, Economics and Statistics Administration, U. S. Department of Commerce.

Exhibit 4a.24

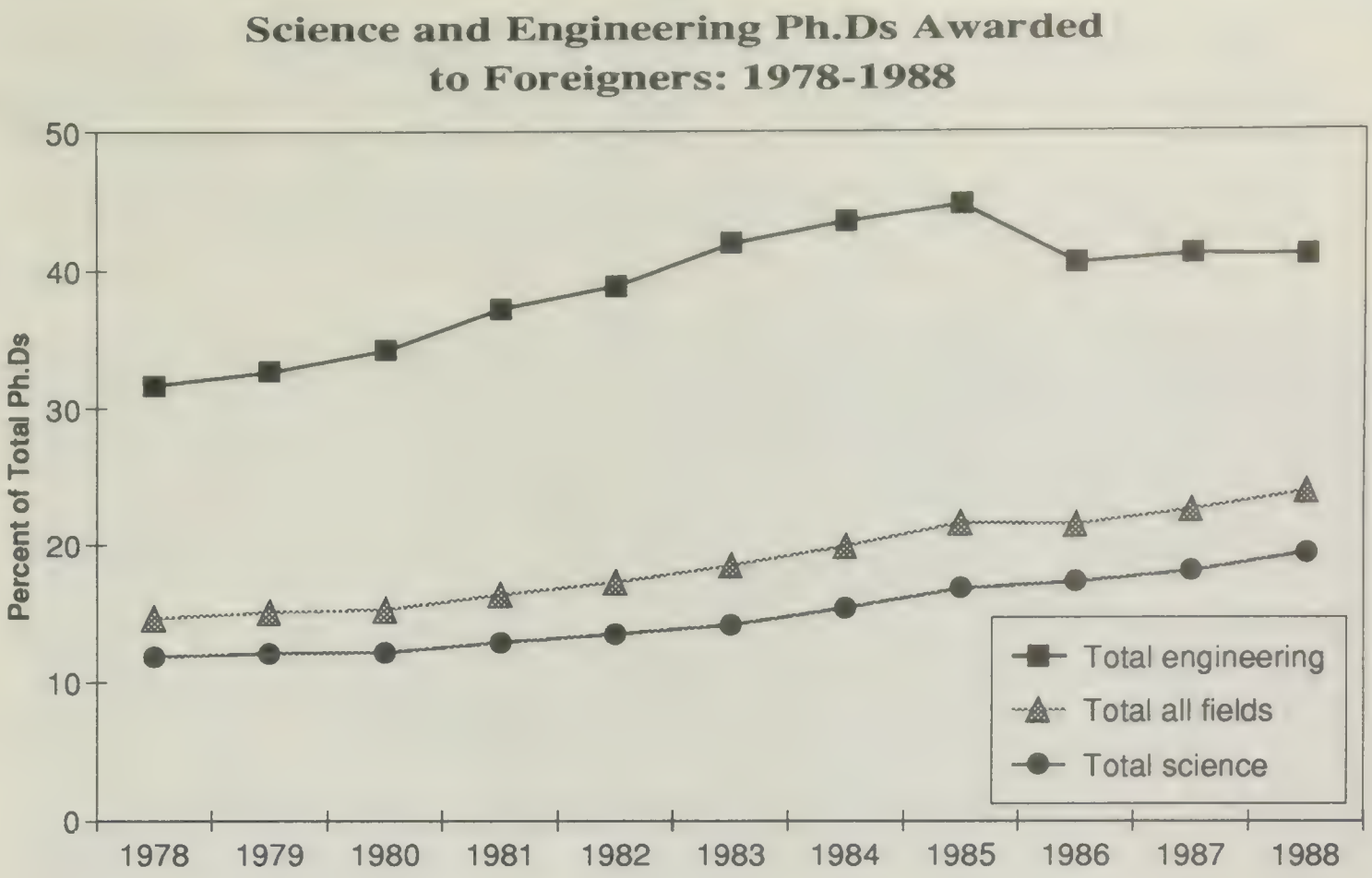
DETERMINING TECHNOLOGICAL NEEDS UNDER THE MONTREAL PROTOCOL

In June 1990, the United States and other parties to the Montreal Protocol on Substances that Deplete the Ozone Layer adopted an amendment establishing a financial mechanism to assist certain developing countries (''Article 5 Parties'') implementing the Protocol. Because the amendment to the Protocol will not enter into force until it has been ratified by 20 Parties, the Parties simultaneously established an interim mechanism to operate until the end of 1993. According to mutual agreement, the interim mechanism will include: 1) a Multilateral Fund to assist developing countries meeting the ''incremental costs'' of reducing their dependence on ozone-depleting chemicals, and 2) a technical clearinghouse to help carry out country studies, disseminate information and provide other forms of technical assistance.

The Interim Multilateral Fund was the result of more than a year of international negotiations. These negotiations benefitted considerably from the completion of several studies about representative developing countries. The studies estimated current and future demand for ozone-depleting chemicals and the potential costs of making the transition to substitute chemicals, products and technologies.

The United States proposed the country studies, and worked closely with three countries—Egypt, Mexico and Brazil—in carrying out the studies. The country studies served as the basis for estimating overall developing country needs. Of equal importance, they contributed to a substantial improvement in government-industry cooperation in all three countries and helped to identify a number of cost-effective projects for future support under the Interim Multilateral Fund.

Source: U.S. Environmental Protection Agency.



Note: Includes only foreigners on temporary visas.

Source: National Science Board, Science and Engineering Indicators - 1989, U.S. GPO, 1989.

Exhibit 4a.25

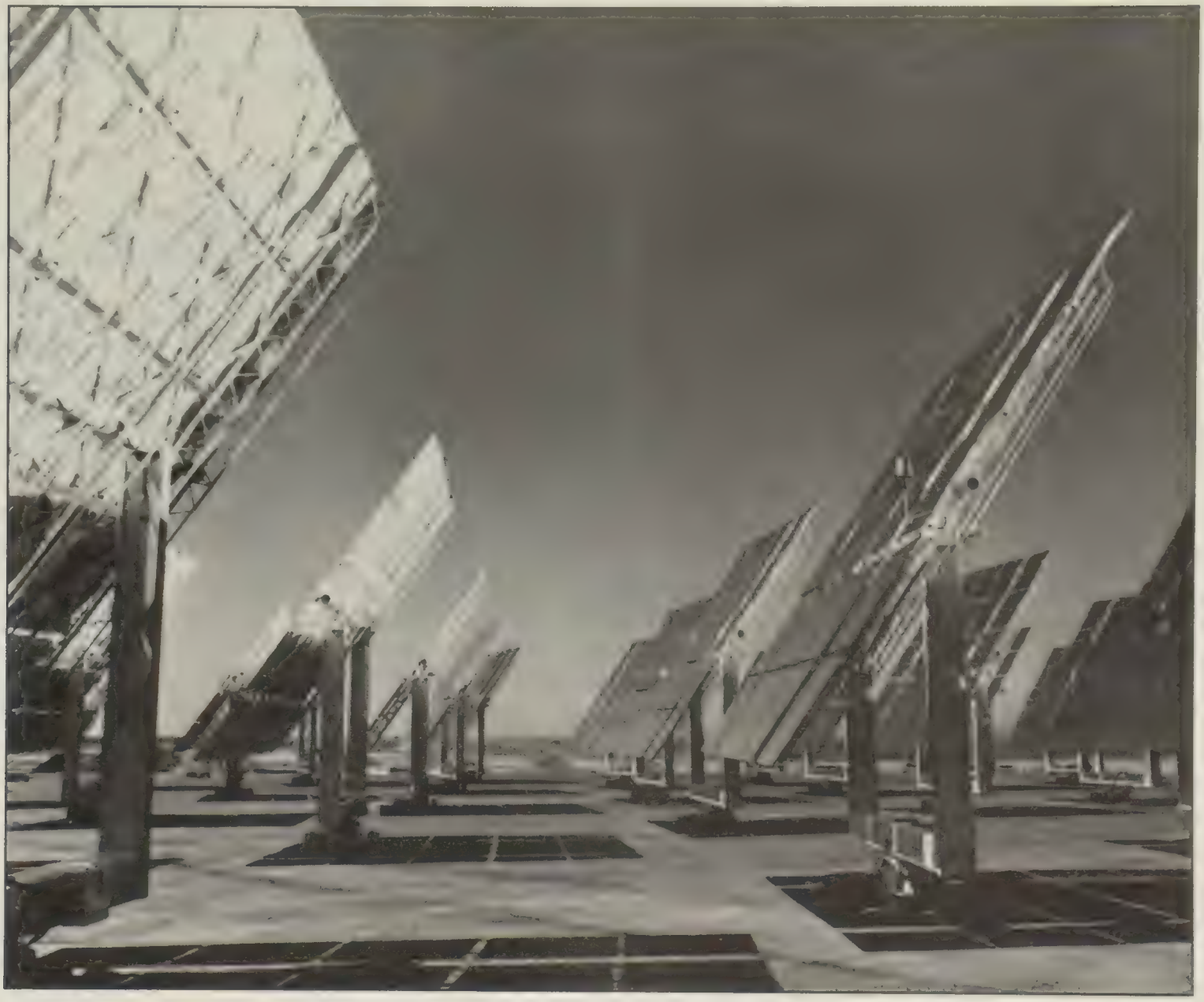
A third important mechanism for the transfer of technology is the scientific and engineering education of foreign students in the United States. While such transfer of technology can occur at the bachelor's and master's degree level, the number of Ph.Ds awarded to foreign students as a percentage of all Ph.Ds awarded is one measure of the process of transferring advanced technical information. As indicated in Exhibit 4a.25, the percentage of Ph.Ds in science and engineering that are awarded to foreign students has increased substantially during a time when the total number of scientific and engineering Ph.D. recipients grew by five percent per year. Non-U.S. citizens on temporary visas earned 15 percent of all science and engineering Ph.Ds in 1978; in 1988 that figure reached 24 percent.

Endnotes:

1. Council of Economic Advisors, *Economic Report of the President: 1991*, February 1991.
2. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business* and Department of Labor, Bureau of Labor Statistics, *Handbook of Labor Statistics*.
3. Michael R. Darby, "The U.S. Productivity Slowdown: A Case of Statistical Myopia," *American Economic Review* vol. 74 (June 1984): pp. 301-322.
4. Council on Environmental Quality, "Making the Environment Count," in *Environmental Quality: Twenty-first Annual Report* (April 1991).
5. Tom Tietenberg, *Environmental and Natural Resource Economics*, 2nd Edition, (Glenview, IL: Scott, Foresman and Company, 1988).
6. U.S. Environmental Protection Agency, *EPA's Use of Benefit-Cost Analysis: 1981-1986*, EPA-230-05-028 (August 1987).
7. Council on Environmental Quality, *Risk Analysis: A Guide to Principles and Methods* NTIS #PB89-137772 (Washington, D.C.: 1989).
8. Merchandise trade as discussed here includes manufactured goods, agricultural goods, crude materials and nonmonetary gold.
9. U.S. Department of Commerce, International Trade Division, Bureau of Economic Analysis, *U.S. Foreign Trade Highlights, 1989* (September 1990), op. cit.
10. See R.J. Kopp, P.R. Portney and D.E. DeWitt, "Comparing Environmental Regulation in the OECD Countries," in *Resources* (Washington,D.C.: Resources for the Future, Fall 1990), pp. 10-13; and M.E. Porter, "America's Green Strategy," in *Scientific American* (April 1991), p. 168.
11. President George Bush's May 1, 1991 response to these concerns states the following: "Mexico and the United States agree that efforts to increase growth through a free trade area should be complemented by cooperative efforts to enhance environmental protection. A strong economy and a healthy environment can be, and should be, mutually supportive." In this same May 1 statement, the President announced that the United States Trade Representative would add representatives of U.S. non-governmental environmental organizations to six committees of private sector representatives who advise the U.S. Trade Representative on trade policy.
12. U.S. Agency for International Development, *U.S. Overseas Loans and Grants*.
13. U.S. Agency for International Development, "Congressional Testimony, Fiscal Year 1991," (February 28, 1991).
14. Abraham Lincoln, Address, Springfield, Illinois, 1859.
15. Congressional testimony by Deborah L. Wince-Smith and Lee W. Mercer, Department of Commerce, May 30, 1991 and March 8, 1990.

—B—

Energy and Environmental Quality



Overview

There have been many changes in the way the United States manages energy and environment interrelationships since the Stockholm Conference in 1972. Experience has been gained in restructuring the use of nonrenewable energy resources (coal, oil and gas, nuclear power) and renewable energy resources (solar, hydroelectric and geothermal power) to recognize the importance of emerging environmental concerns. This section reviews U.S. experiences in energy and environment in the following areas: energy trends in the United States; energy and environment interrelationships; developments in energy technology, resource use and conservation; energy and environmental quality; and energy supply security and economic development.

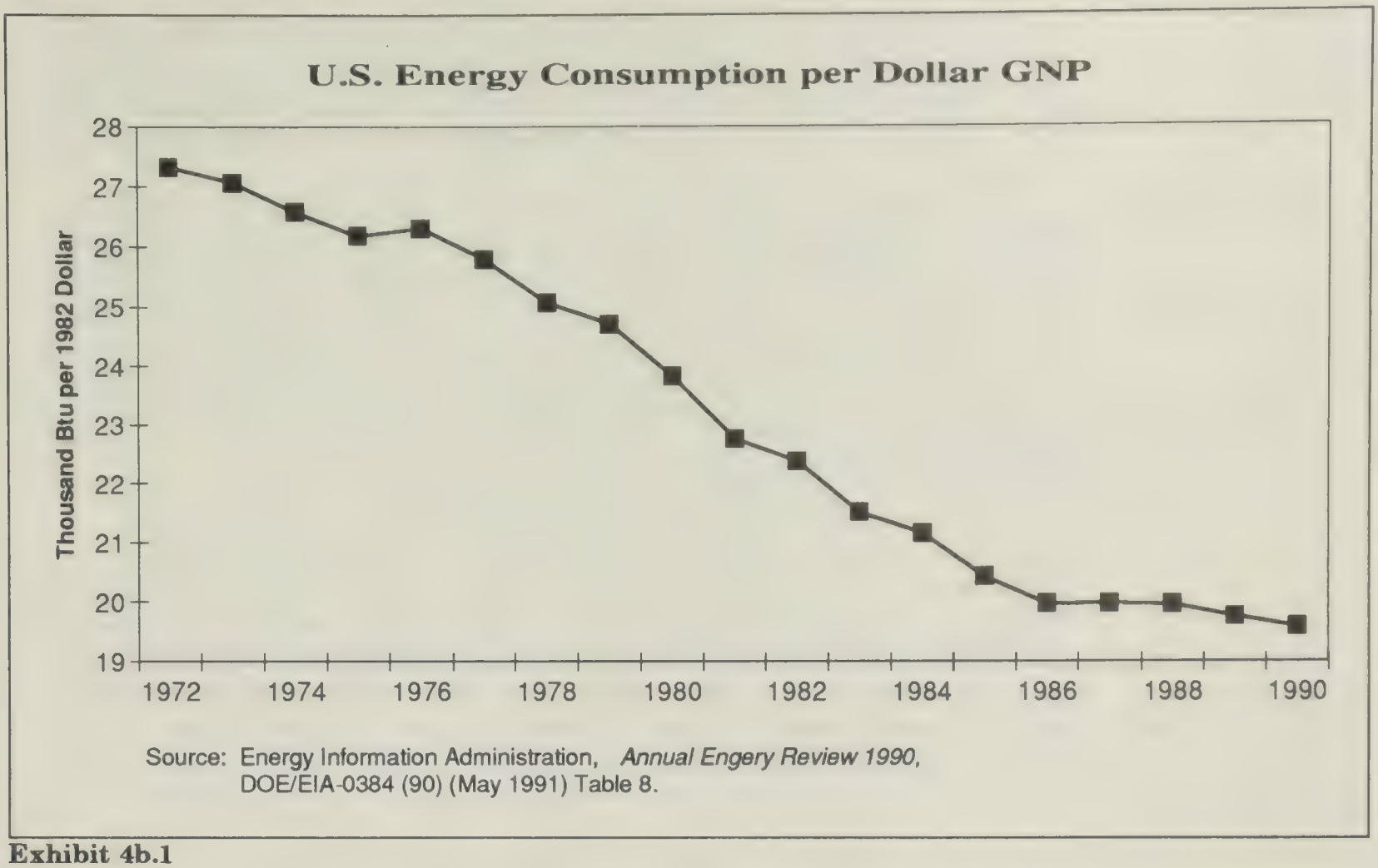
Trends in Energy Production and Consumption

The United States is the world's largest energy consumer and the second-largest energy producer. The nation's patterns of energy use are determined in part by its large land area, low population density and significant indigenous resources. The infrastructure of U.S. cities, highways and industries was developed in response to abundant and relatively inexpensive energy resources. For industries classified at the four-digit Standard Industry Code (SIC) level, the top 10 energy-consuming manufacturing industries account for 70 percent of the total primary consumption of energy by manufacturing industries for all purposes, including feedstocks. These industries account for about 50 percent of energy consumption from off-site energy sources that are used to produce heat, power and electricity.[1]

A primary indicator of the intensity of energy use is the relationship between total energy consumption and real gross national product (GNP) in 1982 dollars. Energy consumption per dollar of GNP has declined persistently over the period 1972-1990. (See Exhibit 4b.1.) It fell from over 27,000 British thermal units (Btu)/dollar of GNP in 1972 (the highest value for the preceding two decades) to 19,000 in 1989, a drop of 28 percent.[2]

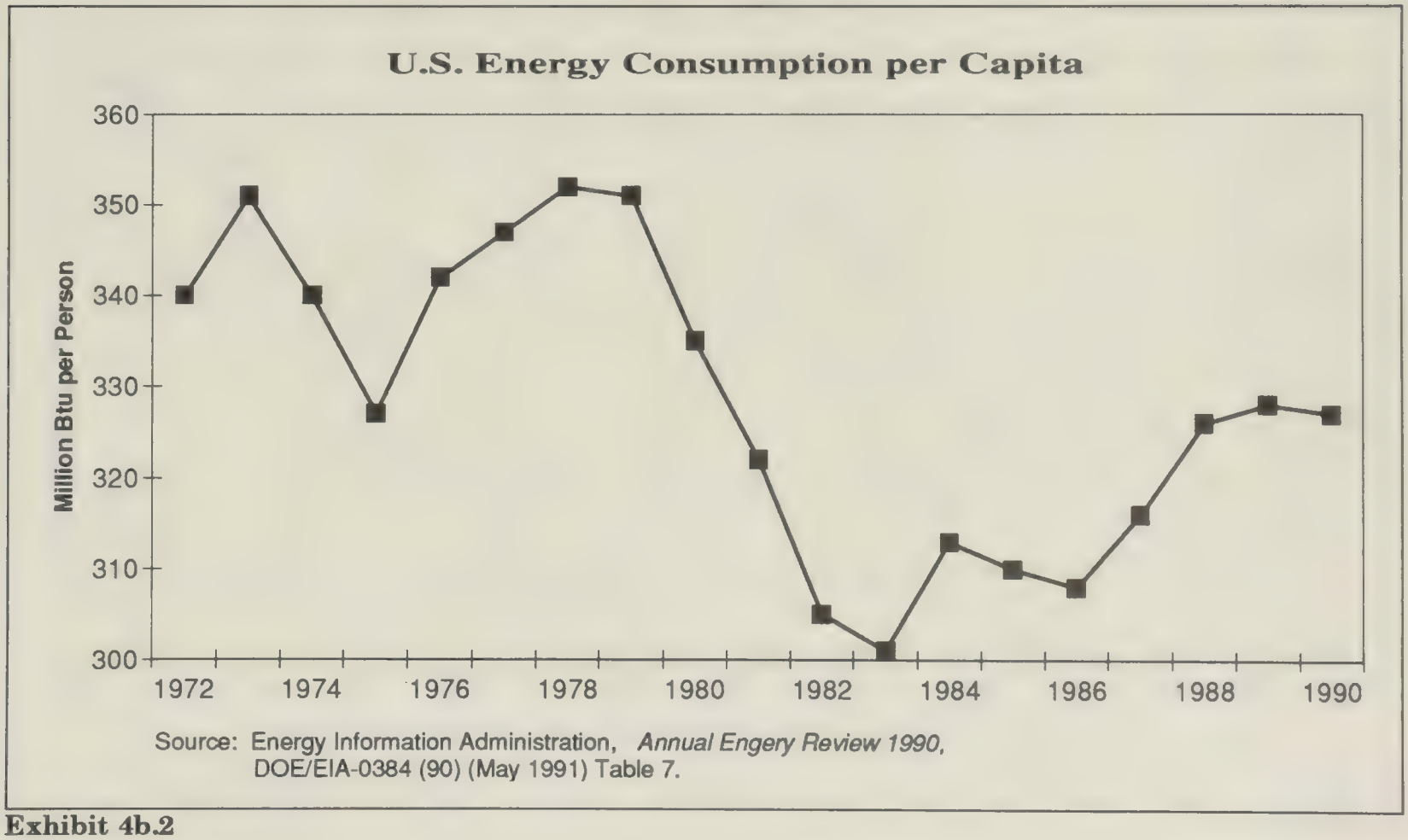
A second measure of energy consumption intensity is consumption per capita, which has remained more stable, declining from 340 million Btu in 1972 to 327 in 1990.[3] (See Exhibit 4b.2.) Consumption per capita from 1972 to 1989 has ranged from just over 350 in 1973, 1978, and 1979 to a low of 301 million Btu per capita in 1983.[4]

A third indicator of energy intensity—energy consumption per household—declined from 138 million Btu in 1978 to 101 million Btu in 1987 (the most recent year for which data are available), with only one small upward fluctuation, which occurred in 1984. Lower use of distillate fuel oil and kerosene accounted for most of the decline. Households in the South and West consumed the least amount of energy in 1987, an average of 84 million Btu per household in the South and 78 million Btu per household in the West. Energy consumption by households in the Midwest averaged 123 million Btu per household. Households in the Northeast averaged 124 million Btu per household in 1987, surpassing the Midwest average for the first time.[5]



Source: Energy Information Administration, *Annual Engery Review 1990,* DOE/EIA-0384 (90) (May 1991) Table 8.

Exhibit 4b.1



Source: Energy Information Administration, *Annual Engery Review 1990,* DOE/EIA-0384 (90) (May 1991) Table 7.

Exhibit 4b.2

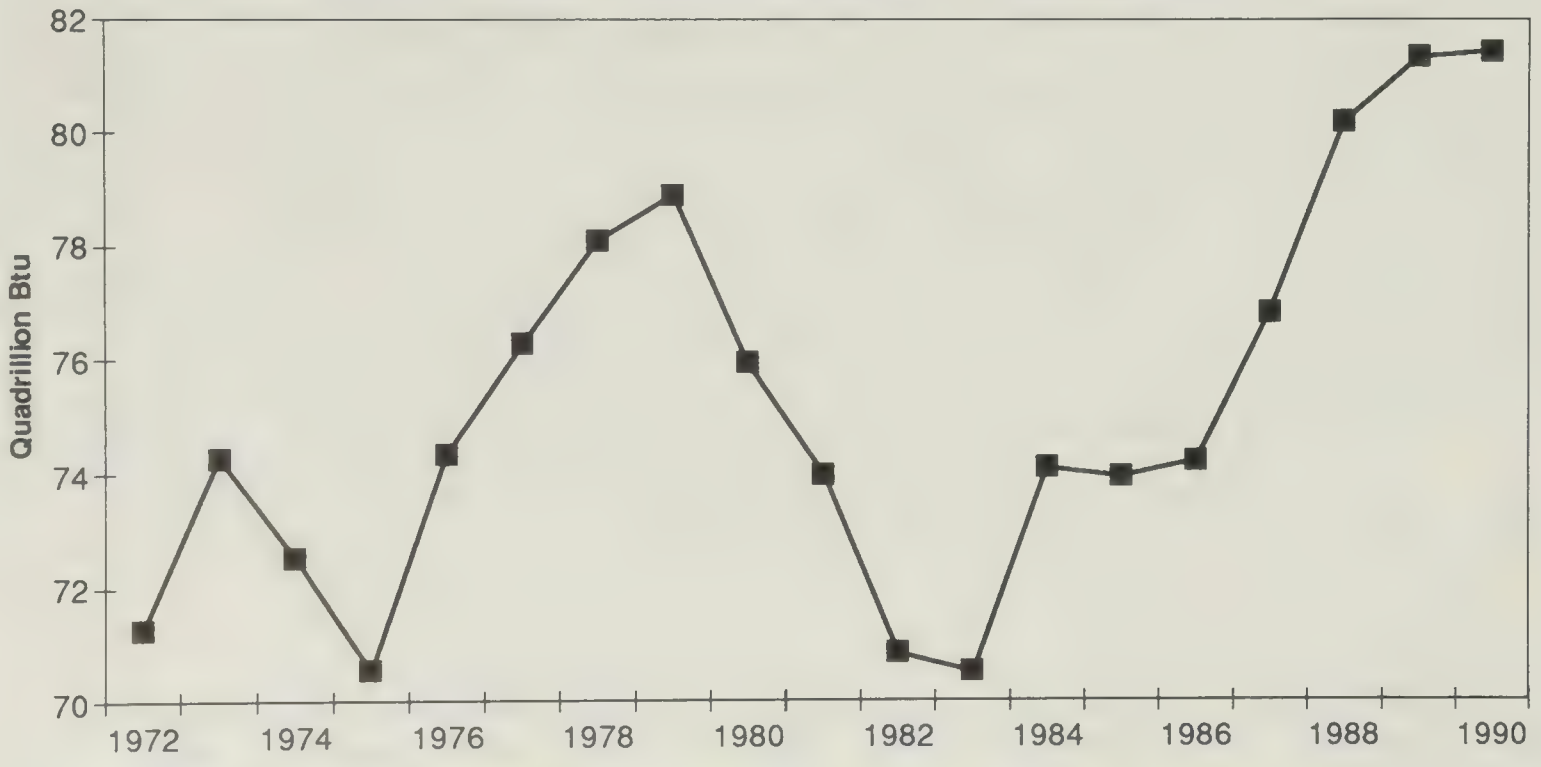
Resource Use and Conservation

Over the period 1972 to 1990, total energy consumption in the U.S. increased 14 percent from 71.3 quadrillion Btu (quads) to 81.4 quads.[6] (See Exhibit 4b.3.) During this period, consumption reached a high of 78.9 quads in 1979, fell to 70.5 quads in 1983 and then resumed growing, reaching its current all-time high.[7]

Over the past two decades, U.S. petroleum consumption fluctuated with the world price for oil, with consumption in 1989 being slightly higher than the 1972 level.[8] (See Exhibit 4b.4.) Natural gas consumption fell over most of the 1970s and 1980s, then increased at the end of the decade. There was a 14 percent drop in consumption from 22.7 quads in 1972 to 19.5 quads in 1989. Coal consumption, on the other hand, consistently rose, increasing by over 50 percent. Consumption of electricity generated by hydroelectric plants remained fairly stable, while electricity consumption from nuclear power increased from 0.6 quads to 5.7 quads.

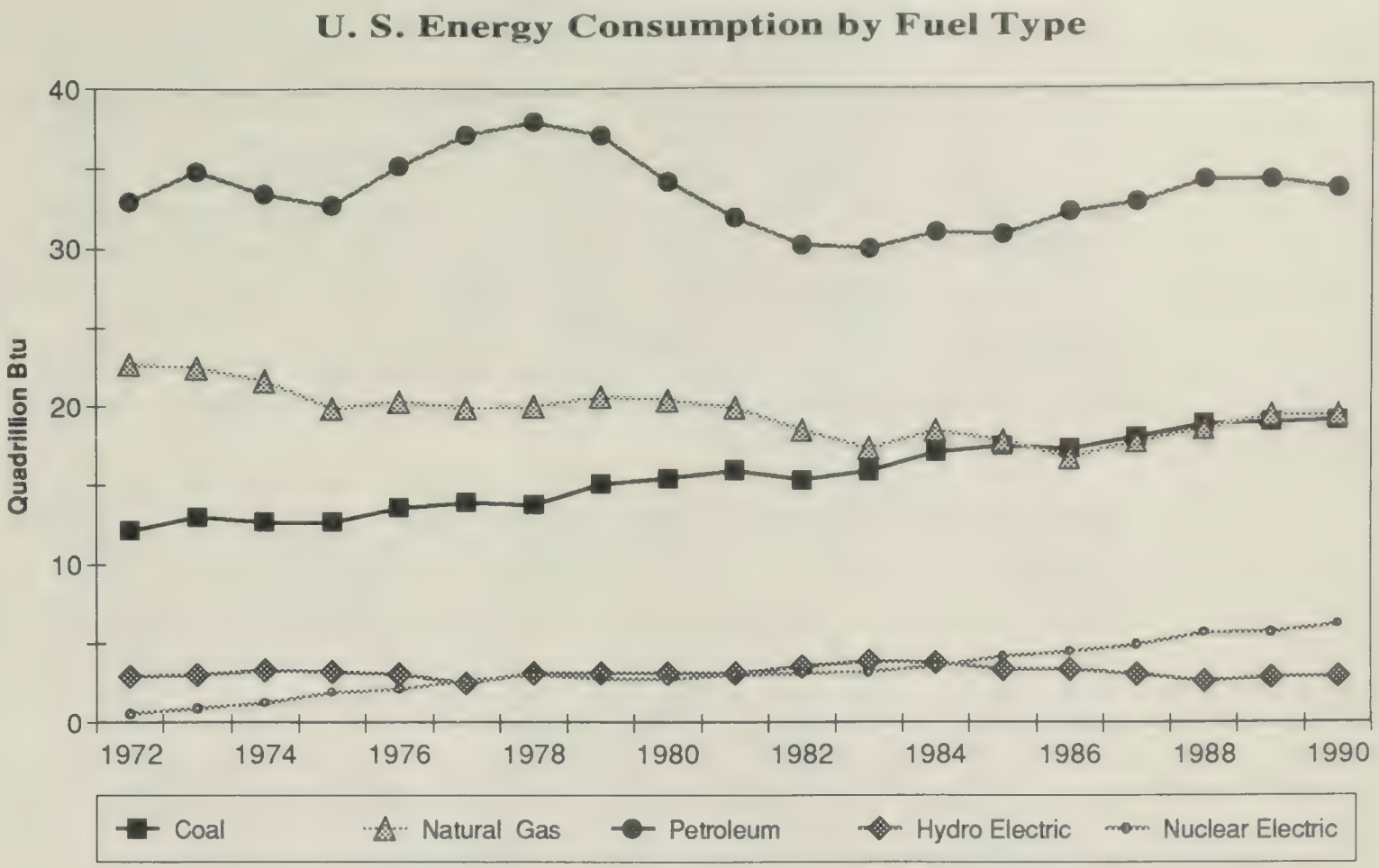
By economic sector, consumption has increased the most in the commercial sector, by almost 40 percent.[9] (See Exhibit 4b.5.) Industrial consumption was relatively unchanged over the period, though it did fluctuate from year to year. Consumption for transportation increased by 25 percent while residential consumption increased about 13 percent. Over the 1972-1989 period, the United States was consistently a net importer of energy. While a relatively small amount of coal was exported each year, reliance on imported oil dominated U.S. imports.

Total U.S. Primary Energy Consumption



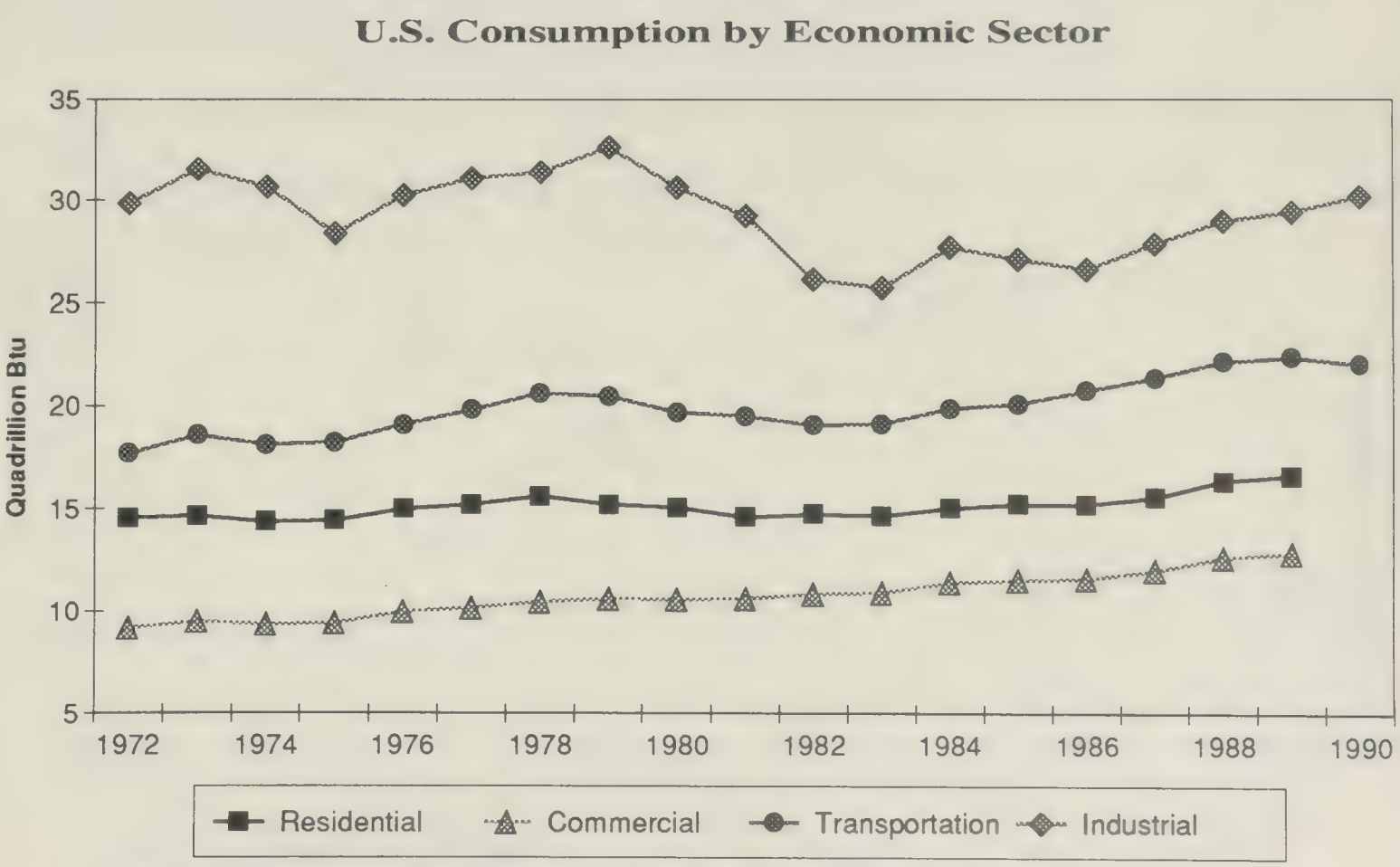
Source: Energy Information Administration, *Annual Energy Review 1990* (May 1991) Table 3.

Exhibit 4b.3



Source: Energy Information Administration, *Annual Energy Review 1990* (May 1991) Table 8.

Exhibit 4b.4



Source: Energy Information Administration, *Annual Energy Review 1990* (May 1991) Table 4.
Energy Information Administration, *State Energy Data Report: Consumption Estimate 1960-1989,* DOE/EIA-0214(89) (May 1991) Tables 10 and 11.

Exhibit 4b.5

Measuring energy conservation is complicated by the varieties of ways in which energy is used. Particularly in industry, the economic sector where consumption is the largest, energy is used in a very large number of different types of processes and equipment. One indicator of changes in U.S. industrial use of energy over time is given by the ratio of energy consumed to the value of real industrial output.[10] (See Exhibit 4b.6.) By this measure, a considerable amount of energy conservation appears to have occurred in the industrial sector, since consumption of energy has fallen from 11,700 Btu per 1982 dollar of industrial output in 1972, to 8,700 Btu in 1985. However, not all of this drop is a result of conservation (the use of more energy-efficient equipment or processes); some of the drop has been produced by a relative decline in the output of industries that are more energy intensive, such as primary metals production.

The transportation sector, the second most intensive consumer of energy, also uses energy in a wide variety of ways. For highway vehicles, good historical data exists on the average rates of fuel consumption per vehicle-kilometer traveled. (See Exhibit 4b.7.) For passenger cars, the average, or "fleet," fuel efficiency rate has increased almost 50 percent, from 18 liters per 100 kilometers in 1972, to 12 liters per 100 kilometers in 1988. For all motor vehicles (passenger cars, motorcycles, buses and trucks), the efficiency gain has been about 30 percent.[11]

Residential energy consumption has also shown a gain in efficiency. Residential use encompasses energy used in the home for space heating, air conditioning, water heating, cooking, and appliances. Energy consumed per housing unit (house or apartment) is a natural indicator of energy use for the residential sector. In 1972, the average primary energy consumption per occupied housing unit was 217 million Btu; this figure fell 17 percent to 181 million Btu in 1988, after reaching a low of 173 million in 1986. The efficiency with which energy is used for most residential end-uses has increased, but there are insufficient data to determine the change for each end-use over the 1972-1989 period.[12] (See Exhibit 4b.8.)

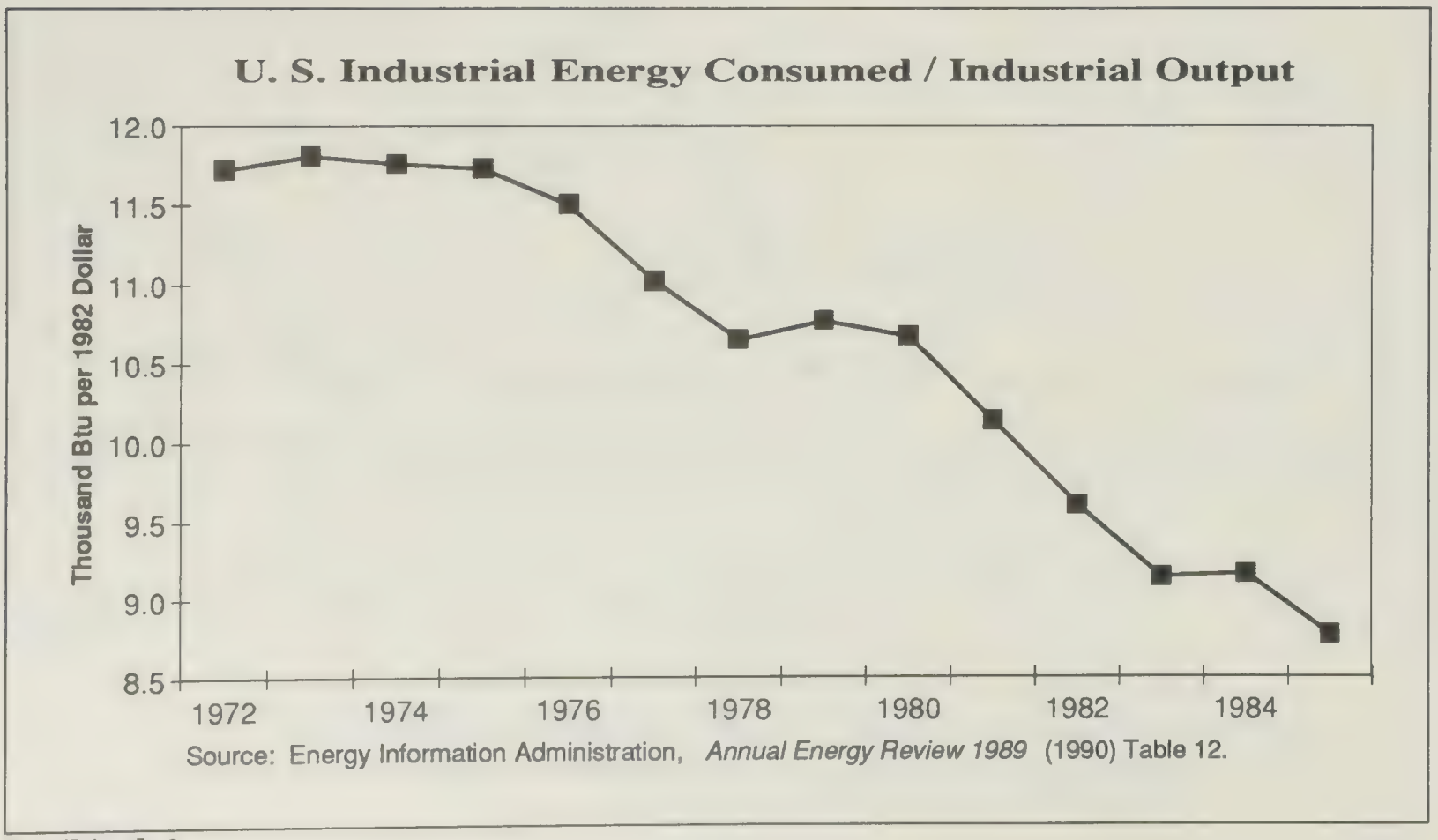
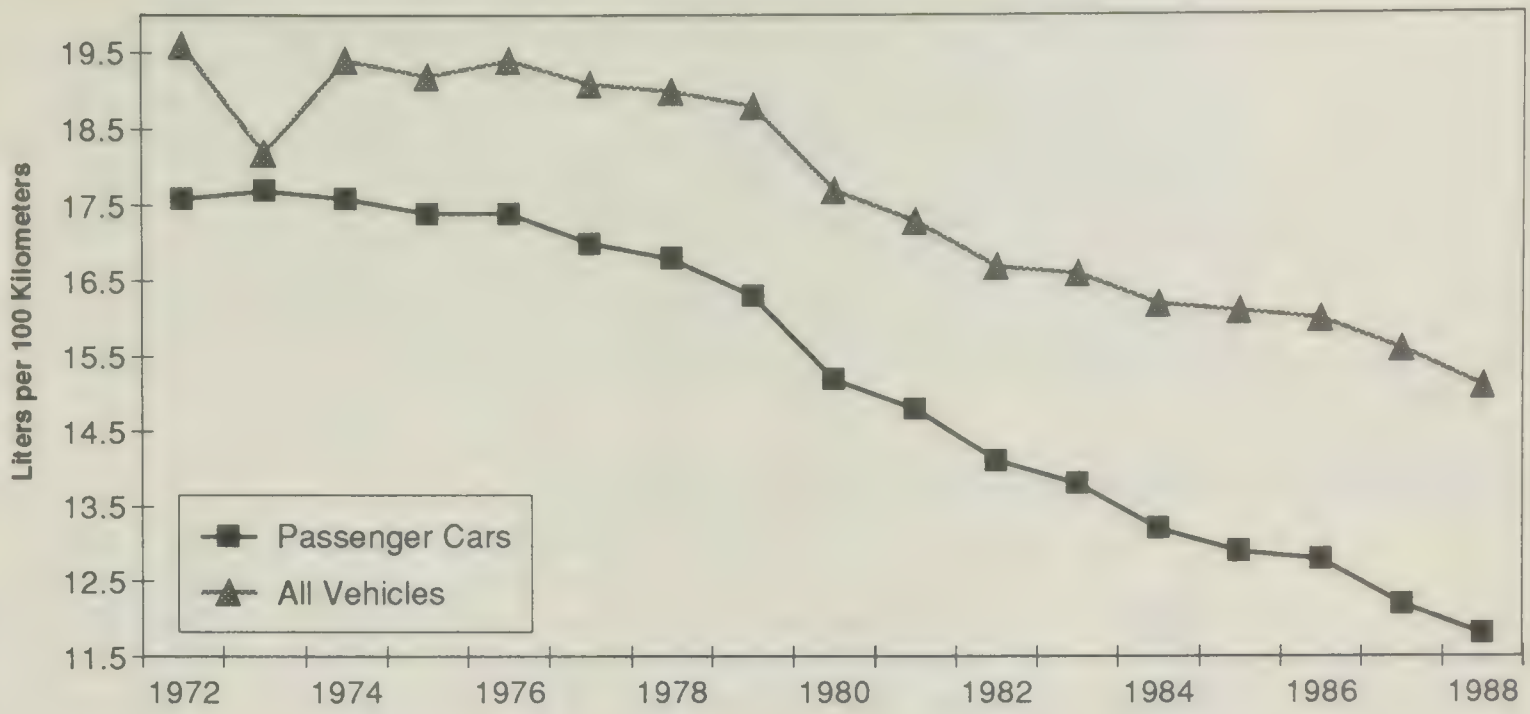


Exhibit 4b.6

Fuel Efficiency, Cars & All Vehicles

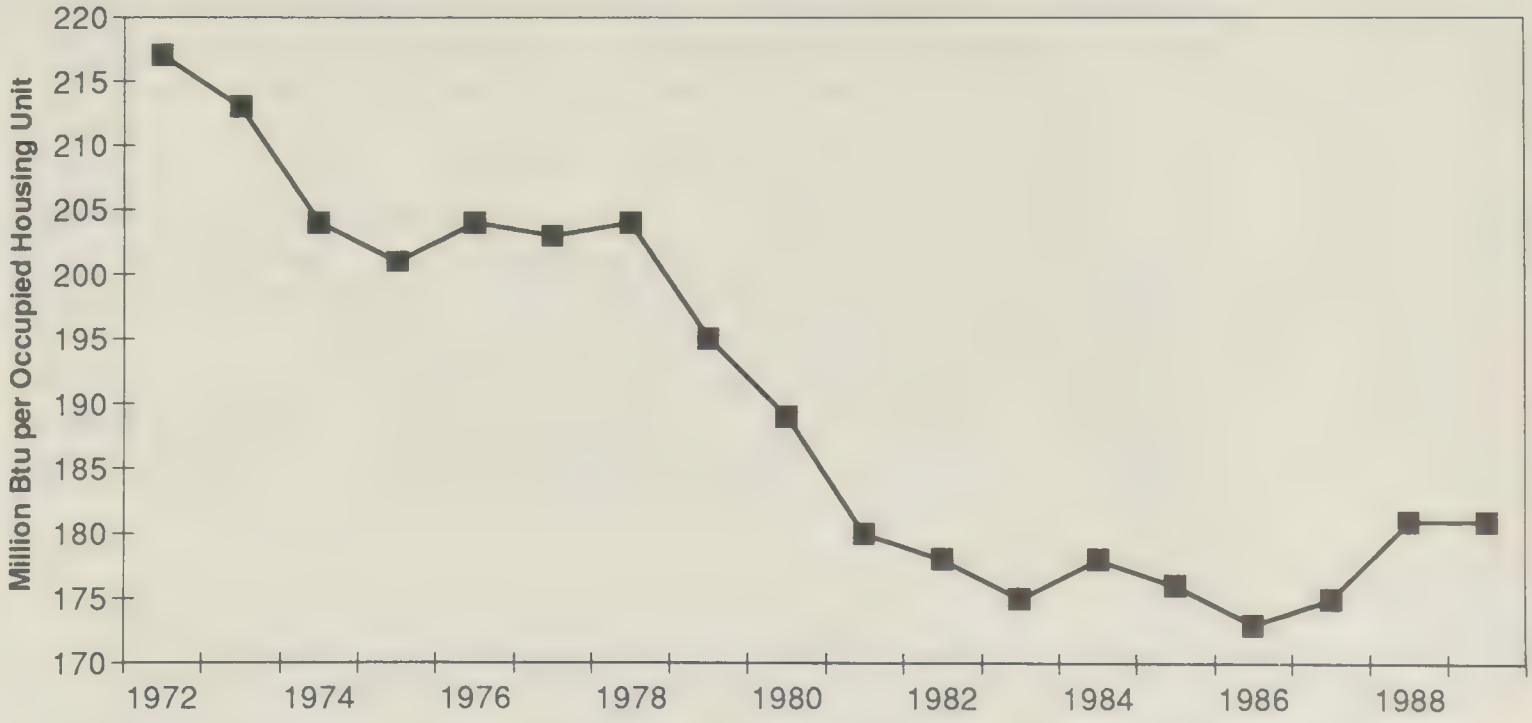


Note: To compute miles per gallon, multiply 235.24 by number of liters per 100 kilometers.

Source: Oak Ridge National Laboratory, *Transportation Energy Data Book.* Edition 11, ORNL-6649, January 1991. Three additional references can be cited here: 1) 1970-1975-U.S. Environmental Protection Agency, SAE Paper 840499 (March 1984); 2) 1976-1990-U.S. Department of Transportation,*Summary of Fuel Economy Performance* (February 1990); and 3) U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook, With Projections to 2010,*1991.

Exhibit 4b.7

U.S. Residential Consumption/Occupied Housing Unit



Source: Energy Information Administration, *State Energy Data Report: Consumption Estimate 1960-1989* (May 1991) Tables 10 and 11.

Exhibit 4b.8

As with the residential sector, commercial energy consumption takes place primarily in buildings; however, limited historical data are available on the number of commercial buildings. Energy consumption within commercial buildings varies widely with building size and the purposes for which buildings are used; consequently it is difficult to estimate the extent of efficiency changes. One measure can be obtained from the Commercial Buildings Energy Consumption Survey conducted triennially by the Energy Information Administration of the Department of Energy. This survey provides estimates of energy consumption and total floor space in buildings that were used primarily for commercial activities. The ratio of total commercial building energy consumption to the estimate of total commercial floor space shows a decline of about 23 percent from 1979 to 1986.[13]

Energy/Environment Interrelationships

Energy production, transformation and consumption each have potential adverse environmental impacts. Coal mining disturbs large tracts of land and can adversely affect the quality of water in nearby streams and underground aquifers. Coal processing produces large quantities of waste; leachate from the disposal sites of such waste can contaminate surface and groundwater. Air pollution from coal-fired power plants and industrial boilers is a concern related not only to human health, but also to the natural environment through the formation of acid precipitation, ozone and other potentially harmful by-products of complex atmospheric chemical reactions.

The use of petroleum products and natural gas is generally thought to have fewer adverse environmental impacts than coal, but is not free from concern. Spills and other accidental releases during production, processing, transportation and storage can contaminate soil and water. The consumption of petroleum products as fuels and lubricants by the transportation sector is a major source of such air pollutants as nitrogen oxides (NOx), volatile organic compounds (VOC), carbon monoxide (CO) and lead. These petroleum products also are a source of hazardous air pollutants, including polynuclear aromatics and cyclic compounds such as benzene. Additionally, the combustion of all fossil fuels (coal, petroleum products and natural gas) produces large quantities of the "greenhouse" gas, carbon dioxide (CO_2).

Renewable energy is not without adverse environmental impacts as well. Wood and other biomass combustion produces substantial quantities of air pollutants, including potentially carcinogenic substances such as polynuclear aromatics. The production of alcohol fuels from biomass can cause air, water quality and sludge disposal problems.

The greatest public concern related to the nuclear fuel cycle is the potential for accidental release into the ecosphere of radionuclides from all phases of the fuel cycle. Water and land contamination are also potential problems, especially in the mining and waste disposal phases.

Ambient Air Quality

Five of the six "criteria" air pollutants regulated under the Clean Air Act (SOx, NOx, CO, particulate matter and lead) are derived largely from discharges emitted directly into the ambient air during the combustion of fossil fuels by stationary and mobile sources. In the United States, electric utilities, industrial plants, and residential, commercial and institutional establishments are defined as stationary sources; mobile sources include automobiles, trucks, railroad engines and off-highway vehicles. The sixth regulated air pollutant, ozone, is formed in the atmosphere by reactions (in the presence of sunlight) with other precursor air pollutants, the most important being volatile organic compounds and nitrogen oxides. Ozone and

peroxyacetyl nitrate (PAN), an organic nitrogen compound derived from NOx, are associated with the phenomenon known as smog.

In 1983, fossil fuel combustion at stationary sources produced 80 percent of the SOx emissions in the United States, 50 percent of the NOx, and 29 percent of the particulate matter (PM), together with smaller quantities of other pollutants. Coal combustion is an especially significant source of SOx, contributing 90 percent of the fossil fuel-related emissions and over 70 percent of the total national emissions. Mobile sources (primarily those consuming gasoline) were the major contributors of CO and lead emissions, accounting for 70 percent and 87 percent, respectively, of these emissions nationally in 1983; mobile sources also produced 45 percent and 36 percent respectively of NOx and VOC emissions in that same year. (As discussed in the Chapter 6 section on toxic substances, vehicular lead emissions have since been dramatically reduced.) For PM, VOC and, to a lesser extent, SOx, sources not related to energy combustion (primarily industrial processes) also make significant contributions to total emissions.[14]

Acid Deposition

Acid precipitation (e.g. as rain, snow and sleet) is more acidic than normal due to the inclusion of acid-forming air pollutants. Acid is also deposited as dry form, known as dry deposition. Emissions of SOx and NOx are considered the major precursors of acid deposition. Other substances, including VOC and chlorides, contribute to the complex set of chemical transformations in the atmosphere that result in acid deposition.

During a ten-year study of acid deposition, the National Acid Precipitation Assessment Program (NAPAP) evaluated a variety of potential environmental effects. Aquatic effects of acid deposition can include the loss of neutralizing capacity in surface waters, particularly in watersheds that do not absorb sulfate, resulting in increased acidity and increased release of inorganic aluminum, which is toxic to aquatic organisms. Acid deposition contributes to reduced growth in red spruce trees at high elevations and changes in ecosystem dynamics, and may have an indirect role in increased tree mortality, decreased reproduction, visible injury, increased sensitivity to cold damage and depletion of forest soil nutrient capacity. But NAPAP concluded there was "no evidence of a general or unusual decline in forests in the U.S. and Canada due to acid rain."[15]

Greenhouse Effects

As noted above, fossil fuel combustion produces large amounts of carbon dioxide; in the atmosphere, this gas is estimated to contribute about half of the potential for greenhouse warming. (This subject is discussed in the Chapter 6 section on climate change, which presents options for controlling emissions of CO_2 and other greenhouse gases.) The proposed actions described there have numerous benefits that are *not* subject to the considerable scientific and economic uncertainties related to potential climate change. For example, improving energy efficiency and switching to lower-emission energy sources will reduce air emissions (including CO_2) as well as help achieve the nation's energy supply security and domestic energy supply objectives. Alternatives to current fossil fuel sources include hydropower, biomass, wind, solar energy and nuclear power. In transportation, alternatives include expanding use of non-petroleum fuels and introducing vehicles that are more fuel-efficient or that rely on electricity and/or solar power.

Indoor Air Pollution

Energy conservation techniques, which have been increasingly used in recent years as a result of rising energy prices, tend to reduce the rate of air exchange between the outside and inside of buildings. Reduced air exchange can result in increased concentrations of indoor pollutants. As research on indoor air quality progresses, the need for indoor pollution control strategies may develop. Methods to reduce pollution from wood-burning stoves, increased mechanical ventilation with air-to-air heat exchangers, the use of air-cleaning equipment, and the restricted use of certain energy technologies or products in the home are among the options that may be considered.

Water Quality

Adverse effects on surface and groundwater from the extraction and use of energy resources (primarily coal, uranium, oil and natural gas) may occur at various stages. Some disruption of local surface and groundwater resources are generally unavoidable during most extraction activities but usually can be reduced in scale and duration by good management practices. Poor practices, however, can result in contamination problems. Contamination of surface or groundwater during other stages of the fuel cycles generally results from accidents or inadequate waste disposal practices. Contamination can occur below waste disposal areas or through loss of petroleum products during transportation, storage or processing.

Storage and Disposal of Wastes

Solid and Hazardous Wastes. Energy-related activities generate several types of waste requiring storage and disposal. Coal-fired power plants produce two principal wastes: sludge from flue-gas desulfurization (FGD), and collected fly ash from particulate control devices installed in smokestacks. These wastes contain toxic trace elements (e.g., arsenic, lead, cadmium and selenium) and radionuclides, primarily due to the presence of those substances in the coal itself. In high concentrations, these elements may present an environmental hazard. Other wastes generated by energy-related activities include bottom ash from coal combustion, coal-cleaning wastes, and muds and brines from oil drilling; these wastes may also contain toxic substances. Acidic drainage from land storage and disposal sites containing these wastes can be contaminated with substances such as iron, manganese and sulfate ions and harmful quantities of other metals.

Radioactive Wastes. Various forms of radioactive wastes are produced in the nuclear fuel cycle and in some institutional and industrial processes. The major potential route for human exposure to these wastes is contamination of drinking water and food, the ingestion of which would expose body tissues to radiation. Inhalation of airborne radioisotopes, primarily radon, and also iodine and tritium, is also a potentially significant exposure pathway. A large volume of slightly radioactive mill tailings is produced when uranium ore is crushed and chemically treated to extract uranium oxides and produce yellowcake (an intermediate product in the production of nuclear power plant fuel). These wastes contain radioactive decay products and sometimes other hazardous or potentially hazardous substances such as arsenic, selenium and molybdenum, depending on the source of the ore and the reagents used in the milling process. Since tailings are subject to wind and water erosion, both air and water pollution are disposal concerns. Health and environmental risks from radioactive wastes can be reduced by the application of waste management and waste minimization practices at all stages of the nuclear fuel cycle.

Almost all commercial power reactors in the United States are light-water reactors (LWRs), which use ordinary water instead of heavy water as the heat-transfer medium and as moderator for the nuclear reaction. As many as 250 activation products, 460 fission products and 80 transuranic

radionuclides are present in the nuclear fuel and cooling system during plant operation, but only a few of these radionuclides have any significance for public health or the environment.

Gaseous fission and activation products are stripped from the reactor coolant, processed in a gaseous waste treatment system that provides residence time for the decay of short-lived gaseous radionuclides and discharged in a controlled fashion. Gaseous wastes from valve and equipment leakage are processed by air filters.

Liquid radioactive wastes include excess reactor coolant, collected drainage, and leakage from valve stems and pump seals. These wastes are cleaned and as much water as possible is recycled. Low-level radioactive solid wastes consist of items such as used filters, evaporator residues, demineralizer resins, and contaminated clothing and rags. These wastes are packaged in accordance with safety regulations and shipped to commercial burial sites.[16]

Developments in Energy Technology and Resource Conservation

During the last two decades, concerns about energy supply disruptions, growing public awareness about the adverse health and environmental impacts of many existing forms of energy development, and unstable energy prices came together to define a new course for energy research and development in the private sector and all levels of government. In broad terms, this research is organized around five different approaches to solving emerging energy and environmental problems:

- Increasing the amount of energy that could be produced efficiently from domestically available renewable resources;
- Developing strategies and technologies for reducing the energy demand required to provide energy services to end-users;
- Increasing the energy conversion efficiency of technologies for generating electricity, while reducing air pollution;
- Improving the safety of nuclear power plants;
- Supporting long-term basic research aimed at creating new energy conversion technologies, such as fusion and hydrogen-based systems.

Some specific examples of these approaches are outlined below.

Renewable Energy Sources

Renewable energy technologies use resources that are not depleted, such as falling water, heat and light from the sun, and the force of winds, to produce energy in a variety of forms, including electricity, gas or liquid fuels, and direct heat. In 1982, renewable resources—principally geothermal, biomass and hydropower—accounted for only about seven quads of primary energy production. Although it has remained close to that level through the 1980s, renewable energy use is now projected to grow from 17 to 22 quads annually by the year 2030.[17]

Renewable resources are attractive for two main reasons. First, from the perspective of energy supply security, use of these resources as alternatives to fossil fuels would help to lessen U.S. dependence on foreign sources of petroleum. Second, from an environmental quality perspective,

renewable resources tend to be more environmentally benign than do conventional resources, although the adverse environmental impacts of hydropower facilities can be quite severe. The primary problems associated with developing these resources have been the unevenness in their geographic availability, associated energy storage problems, and high energy production costs. Although the period from 1982 to 1991 saw little if any growth in the use of renewable energy resources, several developments are summarized below.

Hydropower. The period covering 1982 to 1991 witnessed modest growth in hydropower capacity in the United States, primarily by increasing capacity at existing sites. However, some important technological developments led to increased efficiency of low-head hydro systems. In addition, siting requirements for hydro facilities were made more stringent, as were requirements for taking measures to protect fish.

Biomass. Biomass resources used for electricity generation consist of fibrous primary and secondary waste materials from wood and agricultural production and processing, as well as municipal solid wastes. Burning of municipal solid waste to produce electricity emerged as an option in the 1980s to help reduce the need for solid waste landfills, which produce methane, a significant greenhouse gas.

Geothermal. Geothermal energy uses include electricity generation and direct heat applications such as geothermal heat pumps and district heating systems. Advantages of geothermal energy are the very large domestic resource base, the modularity and short construction lead-times of geothermal systems, and relatively small environmental impacts. Much research has focused on identifying and characterizing the size of the available resource base and building demonstration plants. Geothermal energy production in 1972 was 0.03 quads, while in 1990, it was 0.18 quads.[18]

Windpower. The principal advantages of windpower technology that emerged during the period were its modularity, short construction lead time, and relatively small environmental impacts. The decade of the 1980s saw some growth in the use of this resource, primarily on "wind farms" in California. Installed capacity reached about 400 MW in 1985 and then dropped sharply due to changes in tax subsidies.

Solar. Solar power includes three different types of generating technologies: 1) solar thermal electric, which uses highly concentrated radiant energy from sunlight to produce thermal energy which, in turn, generates electricity from conventional steam turbines; 2) photovoltaics, which are solar cells that convert sunlight into electricity directly; and 3) solar heating, which uses radiant energy from sunlight to produce thermal energy used in direct heating applications. Developments in solar power research and development (R&D) in the 1980s consisted primarily of building demonstration solar thermal electric plants and increasing the efficiency of solar cells. Installed solar capacity peaked in the mid-1980s and then declined, like windpower, due to the ending of tax subsidies. Currently, there is only 355 MWe installed capacity of solar power in the United States, with more than 95 percent located within the Mojave Desert in California.[19]

Biofuels. Biofuels are liquid and gaseous fuels produced from biomass materials. The major types of biomass fuels are ethanol, methanol, synthetic hydrocarbon fuels (synfuels) and biomass-derived methane. Research on

biofuels focused primarily on assessing the resource base and the indirect energy requirements for these fuels, identifying the carcinogenic and mutagenic properties of synfuels, and developing demonstration plants for synfuels. High production costs, low energy prices and withdrawal of tax subsidies prevented any of these technologies from gaining significant ground during the 1980s. Alcohol fuels are clean-burning and reduce the level of carbon monoxide and ozone produced in emissions from transportation vehicles. In addition, these alcohols can be converted to ethyl tertiary butyl ether (ETBE) and methyl tertiary butyl ether (MTBE), with two high octane blending stocks, totally compatible with the present vehicular mix in the United States. Combustion of biomass-derived fuels emits no net carbon dioxide to the atmosphere. Disadvantages include the lower energy density of biomass resources, which effectively limits the economically transportable range of the raw materials, and the potential for competition among traditional resource users.[20]

Reducing Energy Demand

As shown previously, energy consumption increased dramatically in the United States during the post-World War II period until the first OPEC oil embargo in 1973. Gasoline and heating oil supply shortages in the United States helped to focus attention on the fact that the nation was relatively energy intensive compared with many industrialized Western European countries. As a result, increased attention was focused on the large potential in the United States to reduce energy consumption through energy conservation.

In its earliest form, the term energy conservation was used in the United States to identify measures that individuals could take to reduce energy consumption, such as by turning down a thermostat, turning off lights or even closing off rooms. As the magnitude of the energy supply problems of the 1970s and early 1980s grew, the concept of energy conservation was expanded to include changes such as increasing the efficiency of energy-using durable goods, better insulating residential and commercial structures, and installing more efficient heating and air-conditioning units and other appliances. By the early 1980s, the scope of energy conservation was extended to include the basic design of commercial and residential structures.

Initially, energy conservation activities were encouraged purely for energy supply security reasons—to reduce costly energy imports. However, it soon became obvious that many energy conservation measures could also be justified on economic and environmental grounds, if one took into account the value of the energy saved as a result of installing more efficient durable goods, along with the capital cost of those goods. From this point it was only a small step to compare the life-cycle costs of conservation measures with the equivalent costs of supply-side technologies for generating electricity. Thus, by the 1980s, the seeds of least-cost utility planning and integrated resource planning had been sown.

Research and development in this area proceeded on several fronts. First, considerable effort was undertaken to quantify the energy-conservation potential of the U.S. economy. By the early 1980s, this relatively unsophisticated approach to energy planning had given way to the development of conservation supply curves, which showed the amount of energy that could be saved as a function of the marginal cost of different energy conservation measures. Research during this period also focused on developing energy conservation standards for buildings and appliances. Although mandatory energy conservation standards for the private sector were ultimately rejected by the federal government, building standards were adopted for federal facilities, and many states and municipalities adopted conservation standards based on the federal model. Finally, partnerships

between the federal government and private industry were created to assist in the development of a variety of energy-conserving technologies in the residential and commercial sectors.

THE GREEN LIGHTS PROGRAM

Green Lights is an innovative program, sponsored by the U.S. Environmental Protection Agency, that encourages major U.S. corporations to install energy-efficient lighting. Using these technologies, energy consumption can be dramatically reduced while delivering the same or better quality lighting. Under this voluntary, non-regulatory program, corporate facilities will be upgraded with energy-efficient lighting wherever it is profitable and maintains or improves lighting quality.

Green Lights will produce multiple national benefits by addressing critical issues of energy efficiency, pollution prevention and economic competitiveness. Corporations that make the commitment to *Green Lights* will profit by lowering their electricity bills, improving lighting quality and increasing worker productivity. They also will reduce the air pollution caused by electricity generation, which includes carbon dioxide, sulfur dioxide and nitrogen oxides. As of October 1991, 122 corporations and 5 state governments were participating with EPA in the *Green Lights* program.

Improving the Efficiency of Electricity Generation

The 1977 Clean Air Act Amendments required new power plants to reduce SO_2 emissions by 90 percent. The primary technology for achieving these emissions reductions was a wet limestone flue gas desulfurization device (FGD). However, the typical operating efficiency of a conventional coal plant with FGD is only 30 to 35 percent. Growing concerns about the role of SO_2 and NOx in regional air pollution and about CO_2 emissions from power plants made it clear that new technologies for generating electricity were needed that were both more efficient and cleaner than conventional fossil fuel plants. Federal and private R&D efforts in this area led to the development of several new alternatives for generating electricity. Of these, four technologies that were in the R&D stage in the 1970s have achieved commercial operation status and two more are in the advanced demonstration stage at this time. These technologies are summarized below.

Integrated Coal-Gasification Combined Cycle (IGCC). Gasification of coal allows the removal of pollutant carriers from the fuel prior to its combustion in the power plant. Emissions of sulfur, nitrogen oxides and particulates from IGCC facilities are significantly lower than from other facilities. IGCC plants require less land than conventional pulverized coal plants; they produce only about 40 percent of the solid waste from a comparable coal plant; and they achieve higher SO_2 and NOx removal at an operating efficiency of nearly 40 percent.

Atmospheric Fluidized Bed Combustors (AFBC). In this design, coal and limestone are fed into a bed of hot particles that are fluidized by upflowing air. The relatively low combustion temperatures achieved by this technology limit NOx formation, reduce ash fusion problems and optimize sulfur capture. AFBC is fuel-flexible and allows plant operating efficiencies in excess of 40 percent.

Pressurized Fluidized Bed Combustors (PFBC). In PFBC systems the fluidized bed is contained within a pressure vessel operating at a pressure generally between six and 15 atmospheres. The PFBC system allows use of a combined cycle, where exhaust gases from a boiler drive a gas turbine generator. An unusual feature of combined-cycle PFBC systems is that steam from the boiler is the primary source of electricity. The PFBC cycle operates at efficiencies in the range of 42 to 44 percent and achieves SO_2 and NOx reductions comparable to AFBC systems.

Natural Gas Combined Cycle. Combined-cycle technology involves the use of hot-combustion gas turbines and steam turbines to generate electricity. Steam is generated with the exhaust from a gas turbine and is then used to drive a steam turbine. Electricity is produced by both gas and steam turbines at efficiencies in the range of 45 percent. The use of natural gas results in substantially reduced emissions of SO_2 and CO_2.

Steam-Injected Turbines. High-pressure steam injection at the fuel combustor stage in gas turbines greatly increases the exhaust-steam heat capacity and mass flow through the turbine. Compared with a simple-cycle gas turbine, the steam-injected gas turbine (STIG) produces more power and operates at even higher efficiencies. The estimated efficiency for intercooled steam-injected gas turbines (ISTIG) is higher than that of advanced combined cycle plants, while capital costs are much lower. SO_2, NOx and CO_2 emissions are reduced substantially below those from pulverized coal plants with FGD systems.

Fuel Cells. The operation of fuel cells is similar to that of a chemical battery except that the fuel and oxidant are derived from outside the cell, rather than contained internally. Fuel cells require only feedstocks of hydrogen and oxygen, which they then convert to water. Fuel cells operate at efficiencies above 45 percent and are in themselves pollution-free, although some pollutants are generated in the preparation of the fuel.

Improving the Safety of Nuclear Power

Currently, about 20 percent of this nation's electricity is generated by nuclear power plants. Nuclear power is attractive because it is not dependent on imported fossil fuel; furthermore, nuclear power plants emit no sulfur dioxide, nitrogen oxides or greenhouse gases. However, nuclear power has had limited commercial success, in part because of the high cost and long lead times associated with nuclear power plant construction, and in part because of ongoing public concerns about the health and environmental consequences of reactor accidents and the disposal of high-level radioactive waste. Since the early 1970s, plans for more than 100 nuclear power plants have been canceled or deferred indefinitely. Only three nuclear power plants are still in the construction phase; these are scheduled to be completed in the next few years.

Concerns about the safety and environmental impacts of nuclear power have helped to stimulate research and development activities in passive reactor safety designs, reduction of the long-lived radioactive elements that are produced by commercial reactors, and high-level nuclear waste management. These activities are summarized below.

Passive Safety Designs. Passive safety systems minimize the need for an operator to intervene in the event of an accident or a breakdown. Passive safety systems use the known physical properties of materials, along with gravity, to remove heat automatically in an emergency, thus cooling the reactor and maintaining its temperature at safe levels. Should reactor temperatures approach unsafe operating limits, passive features shut the

reactor down to prevent damage with minimal reliance on external power supplies or operator action. Passive safety systems eliminate many "active" safety components, such as emergency cooling-water pumps, and generally reduce the size of power plants. They also lead to simplified engineering designs, lower construction costs, and improved power-plant operations and maintenance. Recent federal R&D efforts have focused on incorporating passive safety features into two advanced light-water reactor designs, with the ultimate objective of having a commercial plant with passive safety features in operation by the year 2000.

Reduction of Long-Lived Radioactive Elements. Advanced liquid metal reactors (ALMRs) are sodium cooled and have the potential to consume a significant portion of the long-lived radioactive waste generated by current reactors and to breed additional fuel. There are two LMRs currently in operation, the second Experimental Breeder Reactor (EBR-II), which has been operating in the state of Idaho for two decades, and the Fast Flux Test Facility (FFTF) near Richland, Washington. The initial justification for breeder reactors was the potential exhaustion of fuel for conventional reactors. Discoveries of new uranium supplies, coupled with a dramatic decrease in the demand for uranium, removed this rationale. However, heightened interest in the ability of ALMRs to consume a significant portion of the long-lived radioactive waste created by other advanced liquid metal reactors has led to a resurgence of interest in this technology.

High-Level Nuclear Waste Management. During the 1970s, public concerns grew about the ultimate fate of spent nuclear fuel from commercial nuclear reactors. Years of effort by interest groups and concerned citizens led to the passage in 1982 of the Nuclear Waste Policy Act (NWPA). High-level wastes, defined in NWPA, Public Law 97-425, as primarily resulting from spent reprocessing fuel, also include reactor components from nuclear power and nuclear fuel-processing plants. The act directed the Department of Energy to site, design, construct and operate the nation's first geologic repository for the permanent isolation of spent nuclear fuel and high-level radioactive waste.

The NWPA set forth a comprehensive strategy for resolving technical and institutional issues concerning the disposal and storage of radioactive wastes. In response to the NWPA, the Department of Energy continued investigations to identify candidate repository sites and in 1985 developed a mission plan detailing future activities. In 1986, three candidate sites were approved for further site characterization. In 1987, the NWPA Amendments further limited first-repository site characterization to the Yucca Mountain site in the state of Nevada.[21] Despite several temporary setbacks in siting this facility, this legislation has prompted considerable R&D directed toward developing technologies for safely immobilizing and storing radioactive wastes for long periods of time.

Integrating Energy Production and Environmental Quality

In February 1991, the U.S. government released a National Energy Strategy (NES), marking a significant national effort to provide the foundation for a more efficient, less vulnerable and environmentally sustainable energy future. The U.S. Congress, in turn, began debating the NES, and energy policy became a major focus of the nation's legislative business. The objective of the NES is:

> *"...achieving balance among our increasing need for energy at reasonable prices, our commitment to a safer, healthier environment, our determination to maintain an economy second to none, and our goal to reduce dependence by ourselves and our friends and allies on potentially unreliable energy suppliers."*

President George Bush directed that "a keystone of this strategy" be continuing the successful policy of market reliance. Wherever possible, markets should be allowed to determine prices, quantities and technological choices. In specific instances where markets cannot or do not work efficiently, government action should be aimed at removing or overcoming barriers to efficient market operation. The goal of a healthy environment and reduced dependence on insecure suppliers represent national security, foreign policy and social benefits to which markets are unlikely to give adequate weight. Hence, government must act, alone or in concert with private markets, to incorporate appropriately these considerations; this is a major objective of the NES. The principle elements of that strategy are summarized below.

- *Air Quality.* The NES proposes to reduce energy-related emissions to achieve and maintain the National Ambient Air Quality Standards for carbon monoxide and ozone; to develop cost-effective, flexible control strategies to reduce energy-related emissions of sulfur dioxide (SO_2) and nitrogen oxides (NOx); and to ensure that other air quality concerns are incorporated into policies for energy supply and use.

- *Waste Management.* The NES seeks to develop technologies, procedures and safeguards to ensure that wastes are treated, stored and disposed of in a manner that protects human health and the environment. The NES supports efforts to develop cost-effective, environmentally sound techniques to reduce the quantity, persistence and toxicity of energy-related wastes.

- *Water and Land Use.* The NES proposes actions to ensure that activities associated with energy production protect surface and groundwater resources. Improved procedures to incorporate environmental concerns into energy facility siting and land use will also be developed and implemented.

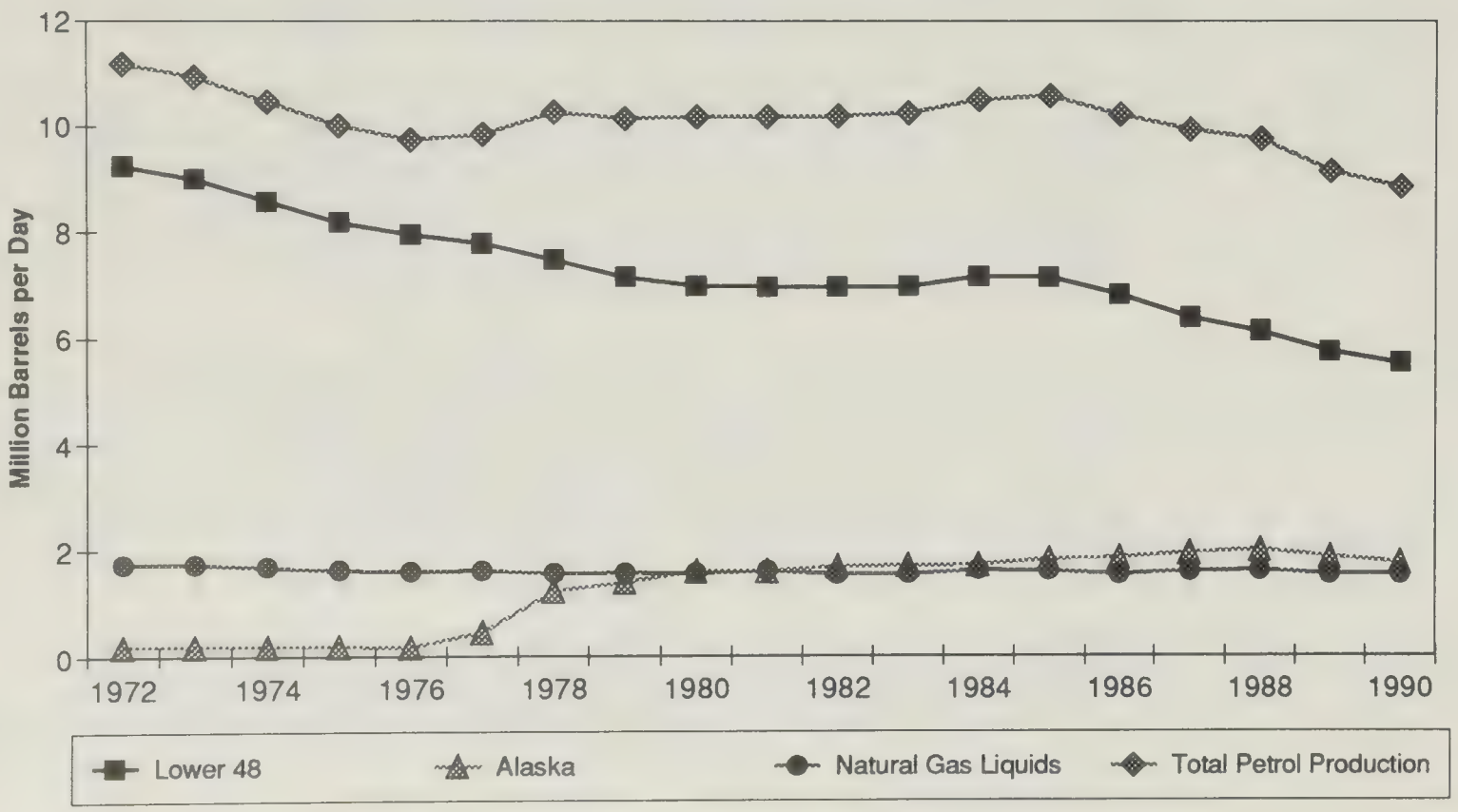
The 1990 Clean Air Act Amendments, which are an integral component of the NES, will limit the major air pollutants from power plants, vehicles and industry. In many cases, pollutants will be reduced from current levels, despite economic growth and increased use of energy. Pollution control programs and NES initiatives, coupled with such Department of Energy R&D programs as alternative fuels for transportation, clean coal technologies, and improvements in energy efficiency, should reduce air and water pollutants and waste even further from projected levels.

More specifically, air quality measures in the National Energy Strategy are expected to reduce emissions of SO_2 by 12 million tons and NOx by 5 million tons in the year 2010. The Clean Air Act Amendments of 1990 and the NES are estimated to reduce SO_2 emissions by 40 percent, NOx by 25 percent and volatile organic compound emissions by 30 percent from the projected levels of emissions in 2030, based on policies that were in place prior to 1990. In addition, the NES includes a pledge to develop new technologies that minimize wastes.

Energy Supply Security and Economic Development

From 1972 to the present, U.S. production of crude oil and natural gas plant liquids has steadily declined. Production of crude oil in the 48 contiguous states has dropped by 38 percent over this period, from 9.2 to 5.8 million barrels per day (bpd).[22] On the other hand, production in Alaska rose from 0.2 million bpd in 1972 to 2.0 million bpd in 1988. Alaskan production dropped slightly in 1989, however, and is expected to continue to fall as the fields in the North Slope enter their period of declining production. (See Exhibit 4b.9.) Petroleum consumption (or total products supplied) has consistently exceeded production, with most of the difference made up from imports.[23]

U.S. Petroleum Production



Note: One barrel is equal to .159 cubic meters.
Source: Energy Information Administration, *Annual Energy Review 1990* (May 1991) Tables 51 and 52.

Exhibit 4b.9

Proved domestic reserves of crude oil, natural gas and natural gas liquids combined have also steadily fallen since 1972, having reached a peak during 1967. By 1989, proved reserves of crude oil had fallen from a 1970 peak of 39 thousand-million barrels to 27 thousand-million barrels. From a peak of 8.2 million-million cubic meters in 1967, proved reserves of natural gas fell to 4.7 million-million cubic meters in 1989. Proved reserves of natural gas liquids stood at 8.2 thousand-million barrels in 1988, down from the peak level of 8.6 thousand-million barrels in 1967.[24] The decrease in U.S. petroleum production, coupled with the increase in total petroleum products supplied, led to an increased dependence upon imported oil during the past two decades. (See Exhibit 4b.10.) Although the United States has been a net importer of oil, it has also exported some petroleum products and smaller amounts of crude oil. Net imports grew from 4.5 million barrels per day in 1972 (43 percent of consumption) to 7.1 million barrels per day in 1989 (41 percent of consumption).[25]

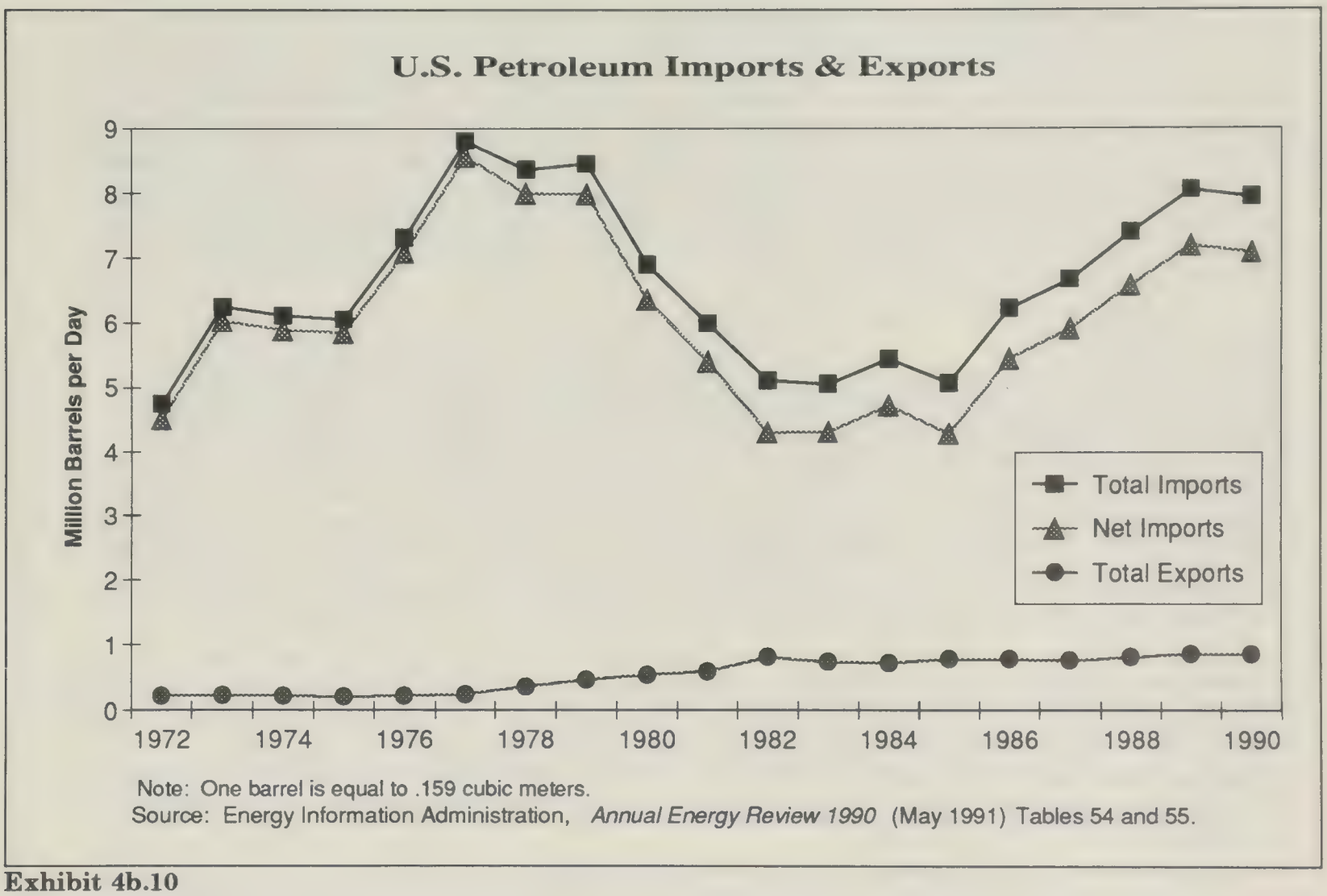


Exhibit 4b.10

For nearly 20 years, the U.S. government has sought to balance the economic benefits of using low-priced imported oil with the foreign policy risks and the security costs of ensuring oil's free flow. These two decades have shown that sudden, dramatic changes in world oil prices are far more harmful to the United States and other nations than a persistent but gradual rise in price, even if the average price over the long term in both sets of circumstances is the same. Vulnerability to oil price shocks is more linked to: 1) how oil dependent the U.S. economy is; 2) the U.S. capacity for switching to alternative fuels; 3) reserve oil stocks around the world; and 4) the spare worldwide oil production capacity that can be quickly brought on-line.

CASE STUDY

PACIFIC GAS AND ELECTRIC COMPANY

The State of California

Numerous studies have shown that the least expensive and most environmentally beneficial source of additional electric energy in the United States is energy efficiency—using the energy we now generate more efficiently. Increasing the efficiency of existing uses of electric power reduces the need for expensive additional generating plants, avoids their associated environmental impacts, and allows utilities to meet additional energy needs with their existing generating capacity.

Pacific Gas and Electric Company (PG&E), a privately-owned utility serving northern and central California, conducted an assessment of the technical and market potential for Customer Energy Efficiency (CEE) in its service territory. The initial results suggested that a savings potential existed for as much as one-third of their current electricity generation. (Other analysts have suggested that the national efficiency potential is much higher). PG&E has created a $10-million program of field-testing advanced efficiency techniques to examine the costs, benefits and validity of such efficiency estimates. The program is guided by a panel that includes representatives from a government's laboratory and two nonprofit environmental organizations, the Rocky Mountain Institute and the Natural Resources Defense Council.

PG&E's plan includes several new supply sources, including upgrades at existing fossil and hydroelectric facilities, and substantial renewable energy sources to be used beyond the year 2000. However, most customer energy efficiency programs are expected to provide electricity from savings more cheaply than electricity can be produced from these new sources. On the average, efficiency savings cost the company $0.05 per kilowatt-hour (kwh), while the lowest-cost supply alternative broadly available costs $0.08 per kwh. The company has committed itself to provide 2500 megawatts from CEE sources by the year 2000 out of a total projected increase of 3300 megawatts in customer demand.

Program Descriptions

PG&E has managed large energy-efficiency programs since the late 1970s. These programs were substantially expanded and refocused as a result of a six-month statewide cooperative negotiation process in 1989 that built a consensus among major utilities, consumer and environmental groups, and state regulators. PG&E now offers efficiency services to all of its 4.2 million electricity customers and 3.5 million gas customers. Spending in 1991 for CEE is expected to be at least $180 million, of which about one-third is in the form of direct cash incentives to customers. The plan for the years 1990 to 2000 calls for more than $2 thousand-million in total CEE program spending; programs offered include the following:

- **Commercial, Industrial and Agricultural Rebates:** PG&E provides cash rebates to customers in these classes who make improvements to their lighting systems, refrigeration units, motors and other machinery.
- **New Construction Programs:** The company offers rebates to builders of new residential or commercial buildings if they exceed minimum California construction standards for energy efficiency by at least 10 percent. Most rebates so far are for advanced lighting and cooling systems.
- **Residential Appliance Programs:** PG&E provides cash rebates to residential customers who purchase refrigerators, air-conditioners, light bulbs and other home appliances that are more efficient than federal or state standards require.
- **Low-Income Service Programs:** PG&E offers weatherization services and certain home appliances at no charge to qualified low-income customers. More than 500,000 homes have been weatherized through these programs. Weatherization of low-income homes involved the following procedures: application of weather stripping for both doors and windows, incorporation or increase of attic insulation, use of water heater blankets, use of low-flow shower heads, insulated wrapping of air conditioning and heating ducts, and insulated wrapping of hot water pipes.
- **Advanced Demonstrations:** The company is subsidizing the construction of a super-efficient home in each of its 25 operating divisions as a demonstration to builders and home-buyers. Also, a $7 million energy center is being built in downtown San Francisco as a site for demonstrating commercially available CEE technologies to the public and for training professionals in their application.

To evaluate the effectiveness of this strategy, PG&E is using surveys of customer use patterns, on-site metering, and other measures to improve their initial estimates of the savings expected from these programs. The results of this effort will be of interest both to utility regulators and to electric supply planners.

The review process that led to the National Energy Strategy confirmed that no feasible combination of domestic or international energy policy options can make the United States completely invulnerable to oil supply disruptions during the foreseeable future. No single policy tool can substantially increase America's energy security. The basic vulnerability involves oil, but reducing this vulnerability requires a broad array of actions: maintaining adequate strategic reserves; increasing the efficiency of the entire U.S. fleet of cars, trucks, trains, planes and buses; increasing U.S. petroleum production in an environmentally sensitive manner; further deregulation of the natural gas industry; and using alternative transportation fuels.

Endnotes:

1. U.S. Department of Energy, Energy Information Administration, Manufacturing Energy Consumption Survey: Consumption of Energy 1988, DOE/EIA-0512(88) (May 1991) Tables 1 and 4, respectively.
2. U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 1990*, DOE/EIA-0384 (90) (May 1991), table 8.
3. Btu, or British thermal unit, is a measure of energy, equal to the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit; one Btu = 1055.87 joules.
4. U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 1990*, DOE/EIA-0384 (90) (May 1991), table 7.
5. U.S. Department of Energy, Energy Information Administration, *Household Energy Consumption and Expenditures, 1987*, DOE-EIA-0321 (87), October 1989, and reports for surveys in earlier years entitled *Residential Energy Consumption Survey: Consumption and Expenditures.*
6. A quad is a very large unit of energy; one quad = one quadrillion, or 10^{15}, British thermal units (Btu).
7. U.S. Department of Energy, *Annual Energy Review 1990*, cited note 2, table 3.
8. U.S. Department of Energy, *Annual Energy Review 1990*, cited note 2.
9. U.S. Department of Energy, *Annual Energy Review 1990*, cited note 2, table 4. U.S. Department of Energy, Energy Information Administration, *State Energy Data Report: Consumption Estimate 1960-1989*, DOE/EIA-0214(89), (May 1991), tables 10, 11.
10. U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 1989* (1990), table 12.
11. Oak Ridge National Laboratory, *Transportation Energy Data Book.* Edition 11, ORNL-6649, January 1991. Additional references: (1) 1970-1975—U.S. Environmental Protection Agency, SAE Paper 840499 (March 1984); (2) 1976-1990—U.S. Department of Transportation, *Summary of Fuel Economy Performance* (February 1990); and (3) U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook, With Projections to 2010* (1991).
12. U.S. Department of Energy, *State Energy Data Report* (May 1991). Cited note 9.
13. U.S. Department of Energy, Energy Information Administration, *Commercial Buildings Consumption and Expenditures, 1986*, DOE/EIA 0318(86); Nonresidential Buildings Energy Consumption Survey (NBECS): Consumption and Expenditures 1983 and NBECS: 1979 Consumption and Expenditures; the 1989 data will be available in early 1992.

14. M. Placet, D.G. Streets and E.R. Williams, editors, *Environmental Trends Associated with the Fifth National Energy Policy Plan*, (Argonne, Illinois: Argonne National Laboratory, 1986).

15. National Acid Precipitation Assessment Program, *Integrated Assessment* (August 1990), (draft). Questions 1 and 2.

16. U.S. Department of Energy, *Energy Technologies and the Environment*, DOE Report DOE/EH 0077 (October 1988).

17. National Energy Strategy.

18. *Limiting Net Greenhouse Gas Emission in the United States: Volume 1, Energy Technologies, Report to Congress* (1991), (draft).

19. Ibid.

20. Ibid.

21. U.S. Department of Energy, *Mission Plan for the Civilian Radioactive Waste Management Program,* vol. 1, DOE/RW-0005 (June 1985).

22. One barrel is equal to .159 cubic meters.

23. U.S. Department of Energy, *Annual Energy Review 1990*, tables 51 and 52.

24. U.S. Department of Energy, *Annual Energy Review 1990*, table 47.

25. Ibid. Tables 54 and 55.

—C—

Agriculture in the U.S. Environment

Overview

The United States enjoys a natural heritage of productive lands and a favorable climate for producing food, feed grains and many other agricultural commodities. It includes extensive grasslands and forests, abundant water, many widely dispersed inland and coastal wetlands, as well as mountains and arid regions. These natural resource systems provide a wide range of landscapes and human habitats and support a rich biological diversity, including wildlife and fish resources that sustain native human populations.[1]

As the population grew from about 3 million Native Americans before the beginning of European settlement in the 16th century to 123 million people in 1930, agricultural production and national development modified the use and management of these natural resources in many ways. The broadest influence of agriculture was the conversion of the more productive forestlands and grasslands and some wetlands to cropland. This conversion closely tracked population growth and migration to the American West. It reached a peak in the 1930s when cropland, including idled cropland, totaled 165 million hectares, just about one-fifth of the area of the contiguous United States.[2] Because crop yields per unit area increased very slowly before 1930, most of the nation's growing demands for food and farm exports were met by increasing the acreage in production. As U.S. agriculture expanded to more productive Western lands in the late 19th and early 20th century, many lands that had been cropped east of the Mississippi River, particularly in the Northeast and parts of the Midwest, were abandoned and reverted naturally to old fields and forest cover.

As extensive herds of buffalo and antelope were virtually eradicated for their meat and hides in the last half of the 19th century, cattle and sheep herding became the dominant use of arid Western grasslands not suitable for crop production. Cattle and sheep herding were permitted without constraint on the federal public domain lands of the West throughout the late 1800s to 1934. The U.S. policy for open and free use of those rangelands provided a strong incentive for cattle and sheep producers to make use of the abundant forage. Until 1934, the public rangelands were free to all users until they were homesteaded, sold or reserved by the federal government for national forests or other purposes. The historical record shows that the public rangelands were generally over-grazed and depleted before the end of the 19th century due to a combination of poor management and sustained droughts. These circumstances continued into the first part of the 20th century. Both the private rangelands and the unmanaged public domain rangelands appear to have reached their lowest condition during the depths of the Depression and the Dust Bowl days of the 1930s.[3]

Soil erosion was recognized as a problem on cultivated croplands during the 19th and early 20th centuries, when conservation and environmental policies for cropland were still negligible. In 1894, the U.S. Department of Agriculture (USDA) published one of its first bulletins on soil erosion, "Washed Soils: How to Preserve and Reclaim Them." It reported that many hectares of good cropland were eroding annually and being abandoned by farmers. Soil erosion continued to be a growing problem into the 1920s and was aggravated by mechanized farming techniques and the depressed agricultural market conditions of that decade. In the 1930s the occurrence of severe drought conditions and wind erosion in the Great Plains elevated soil erosion to the dimensions of a national problem. Sheet and rill erosion and more serious gully erosion were also extensive in the more moist Eastern parts of the country. These conditions were further aggravated by depressed agricultural markets, excess production and widespread farmland abandonment during the depression of the 1930s.

In 1935, the U.S. Congress passed the Soil Conservation and Domestic Allotment Act, declaring soil erosion as a national menace. Soil conservation became a national policy objective; achieving it became the responsibility of the Soil Conservation Service (SCS), a USDA agency. This legislation led to the implementation of federally supported conservation programs through state-established and locally administered soil conservation districts in almost every county of the nation.

Agricultural Performance: 1930 to 1990

From 1930 to 1990, the U.S. population and its need for food and fiber for domestic use and exports more than doubled. The United States developed an institutional, legal, economic, social and cultural framework which stimulated the development and adoption of new technologies and management practices. By 1990, crop production rose about 2.5 times over the 1930 level and live stock production was 2.3 times greater.[4] This 60-year expansion in agriculture was due almost entirely to improvements in cropland productivity, achieved through the use of yield-increasing technologies including drainage, irrigation, fertilizers, improved seeds and plant varieties, and pesticides. Mechanization also proved to be an important influence.

Cropland used remained relatively stable at close to 160 million hectares after the 1930s. Cropland harvested, however, actually declined in response to the yield improvements, from 144 million hectares in 1930 to 124 million hectares in 1990. (See Exhibit 4c.1.) U.S. cropland products include row, sod and closely sown crops, tree fruits and nuts, small fruits and wild hay. In 1987, food crops accounted for 43 percent of the 116 million hectares harvested, and feed crops for 53 percent. Corn production alone accounted for 23 percent of cropland harvested.[5]

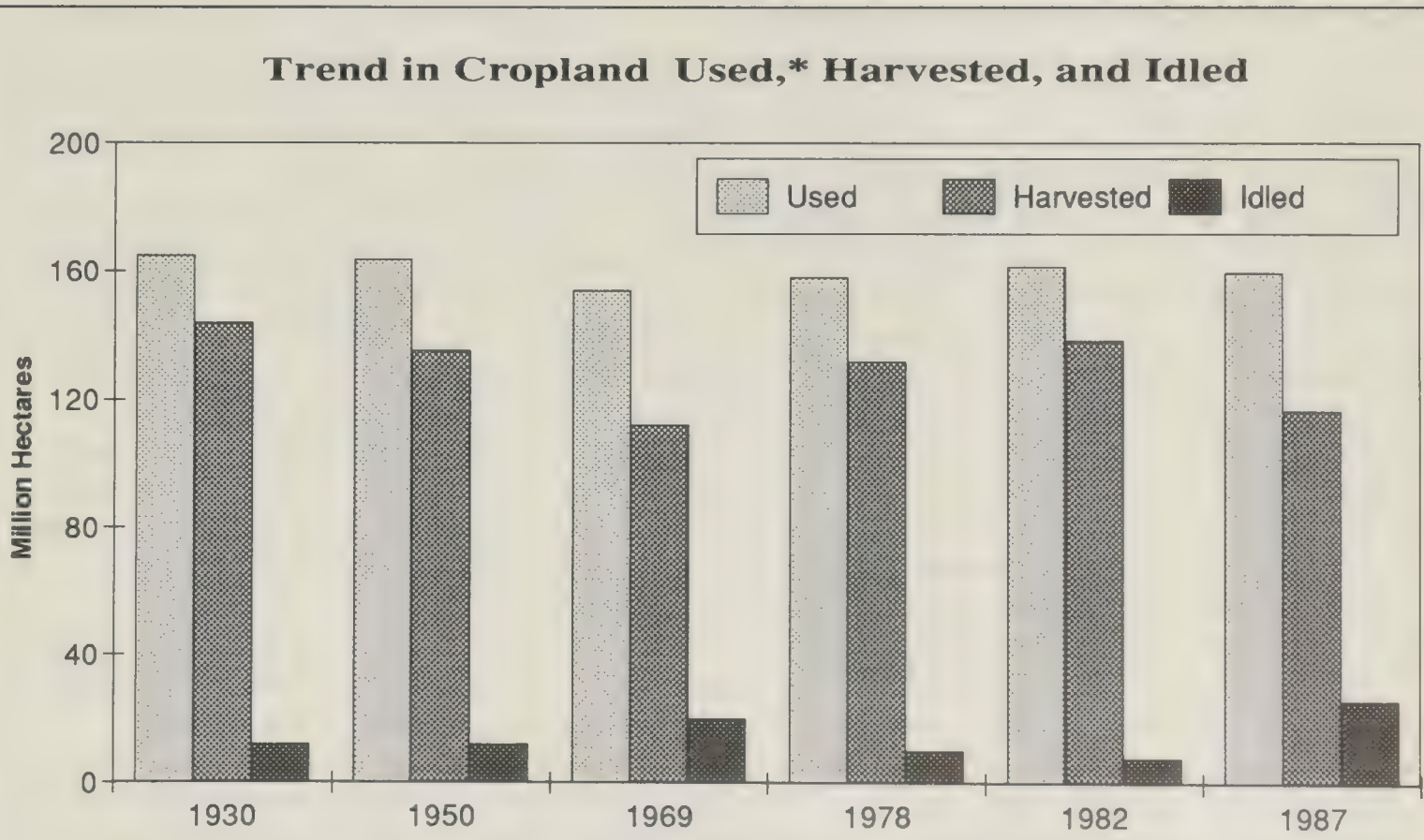


Exhibit 4c.1

Climate, topography, soils and the availability of irrigation water all influence the productivity of agricultural lands. When these factors are favorable and are combined with the application of appropriate production technologies, the result can be the generation of higher yields from the same area of cropland. Various measures of crop productivity show a pattern of continual growth in U.S. farm production. For example, average crop production per hectare was 23 percent higher in 1987 than in 1977.[6] This growth trend in crop yields began in the 1930s, and reflects development and application of new technologies and management practices. Crop productivity per hectare increased faster than domestic consumption plus exports. The steady increase in crop yields per hectare and reduction in harvested land significantly reduced historical pressures for the further conversion of grasslands and forested lands to cropland use. However, limited shifts of land use continued in both directions between croplands and forests and grasslands.

Rangeland conditions generally improved following the nadir reached in the 1930s, due to improved knowledge and management of range forage production and also to less extreme drought conditions. Overall, U.S. rangeland is now considered to be in its best condition since the beginning of the century. About 80 percent is rated as in a stable or improving condition, while the other 20 percent is trending downward or unknown and is classed as in poor or bad condition.[7] The public domain rangelands were placed under federal management in 1934; between 1945 and 1985, grazing on those lands was reduced from 17.8 million animal unit months to 11.2 million.[8] Although conditions on those public lands have also improved, the available data are incomplete and subject to varying interpretation. The most recent published summary indicates that almost 40 percent of public rangelands, administered by the Bureau of Land Management and the Forest Service, are in good to excellent condition; over 40 percent are rated fair, and 16 to 18 percent are rated as poor.[9] Grazing on federal lands represents about seven percent of the total livestock forage grazed and serves two percent of the 1.6 million cattle producers in the United States.[10]

Livestock production per breeding unit also increased more rapidly than the total output of livestock and livestock products. Total output rose 1.8 times between 1947 and 1989, while production per unit of breeding stock rose 2.2 times in the same period.[11] The total number of cattle increased to 86 million in 1945 and to 132 million in 1975. After 1975, cattle numbers declined to 98 million by 1990, as average beef consumption per capita dropped from more than 40.5 kilos in 1976 to less than 36 kilos per year in recent years. Beef cows increased from 16 million in 1945 to 46 million in 1975, then declined to 34 million in 1990, the same level as 1965. Milk cows declined steadily from 28 million in 1945 to 10 million in 1990 as milk production efficiency per cow rose rapidly.

The large-scale erosion of soil from U.S. cropland and rangeland that had been labeled a "national menace" in the 1930s, was reduced from the peak level of more than 3.5 thousand-million tons of total cropland erosion estimated in the 1930s[12] to an estimated 2.6 thousand-million tons in 1967.[13] As cropland planted increased from 123 million hectares in 1967 to over 140 million hectares in the early 1980s in response to public policy and economic incentives, estimated total cropland erosion rose again, to 2.8 thousand-million tons in 1977[14] and 3.0 thousand-million tons in 1982.[15] Much of this cropland expansion occurred on fragile grassland soils and idled croplands that generally were more erodible and less likely to consistently produce a profit than regularly planted land. The expansion also involved a 20-million-hectare increase (from 58 million hectares in 1969 to 78 million hectares in 1980) in cropland planted to row crops such as corn and soybeans,

for which sheet and rill erosion per hectare tends to be severe. Under these conditions, major increases in total cropland erosion would be expected.

During the same period, however, an estimated 12 to 20 million hectares were brought under conservation tillage systems, which complement erosion-control objectives. Erosion rates under conservation tillage systems can be reduced as much as 60 percent (under minimum tillage) and 90 percent (with no tillage) as compared to conventional tillage. Erosion rates rose because the increase in erodible land cropped, the increased acreage in row crops, the removal of terraces to accommodate larger equipment, the removal of windbreaks, the increased size of fields, more crop intensive rotations and other factors contributing to increased erosion outweighed the effect of the increased use of conservation tillage. Also, some of the land in conservation tillage was not highly erodible land; when oil prices rose, some producers adopted conservation tillage on land that was not highly erodible to reduce production costs.[16]

The intensity of cultivation increased in many ways as agricultural production and productivity improved continuously in the decades following the 1930s. Purchased inputs—including feed, seed and livestock purchases, agricultural chemicals, mechanical power and machinery, and hired labor—increased more than 133 percent. Non-purchased inputs—including operator and unpaid family labor, operator-owned real estate and related capital costs—decreased 55 percent. Most of this decrease in non-purchased inputs resulted from a major reduction in farm operator and family labor as the number of farms declined. Total farm employment decreased from 12.5 million farm workers in 1930 to 2.9 million in 1989.[17] Drainage and irrigation investments that permit higher yields per unit area expanded substantially. The total area of rural land drained in 1950 was 20 million hectares. This area increased rapidly to 40 million hectares in 1970. The increase slowed, thereafter, as federal assistance was withdrawn in the early 1970s. In 1980, the total rural drained area was 42 million hectares and in 1985, 44 million hectares, of which 30 million hectares or 70 percent was cropland and constituted about 20 percent of the nation's total cropland base. Two-thirds represented surface drainage only; one-third involved sub-surface drainage systems. This drainage contributed to the losses of wetlands.[18] Irrigated land more than doubled from 1950 to 1977, exceeding 20 million hectares.[19]

The combination of falling fertilizer prices and USDA's development of higher-yielding, fertilizer-responsive crop varieties led private firms and other public agencies to give farmers a powerful incentive to adopt the new varieties as quickly as they became available. As a result, the amount of fertilizer applied per hectare roughly doubled each decade from 1940 to 1979.[20] Total fertilizer use, based on primary nutrient content (including nitrogen, phosphorus and potassium) increased from 7.5 million short tons in 1960 to a peak level of 23.7 million short tons in 1981, when cropland area planted and crop production were at their peak levels.[21] Nitrogen fertilizers made up half of this use in 1981, compared to 37 percent in 1960. After 1981 total fertilizer use dropped 15 percent, averaging a more or less stable 20 thousand-million tons per year to 1990, nitrogen use decreased by 11 percent, reflecting in large part a decline of about 12 percent in total cropland planted. Crop yields per hectare, however, rose about 19 percent without a significant increase in fertilizer use.[22]

The use of pesticides also increased rapidly as the intensity of cultivation grew. Prior to World War II, arsenic and sulfur compounds and oils were commonly used to control insect pests. The development of synthetic organic materials during World War II, such as the herbicide 2-4-D and the insecticide DDT, led to a boom in the development, production and use of

chemical pesticides in agriculture. Total agricultural pesticide use in 1964 was estimated at 144 million kilos of active ingredients. This use rose to a peak level of 396 million kilos of active ingredients in 1982. Since then, the level of use has declined about five percent in response to lower amounts of cropland planted and changes in application rates and types of pesticides used.[23] Other data, reported by the American Farm Bureau Federation, indicate that the decrease in pesticides used for major crops may be closer to 18 percent.[24]

In either case, the recent increases in both crop yields and livestock productivity indicate that farmers have been making more judicious and more effective use of fertilizers and pesticides.

These changes were accompanied by equally significant changes in farm structure. Total U.S. farmland remained relatively stable at about 400 million hectares from 1930 to 1990. The number of farms, however, declined from 6.3 million in 1930 to 2.1 million in 1987, while the average number of hectares per farm increased from 63 to 184.[25] The distribution of farms and the value of production by farm sales class changed even more drastically. In 1949, six percent of the farms (289,000) had farm sales exceeding $40,000 (based on 1980 prices) and were producing 40 percent of the total value of production or farm sales. In 1982, 29 percent of the farms (695,000) had sales exceeding $40,000 (1980 prices) and were producing 88 percent of the total value of production or farm sales.[26]

U.S Agriculture and World Trade

U.S. agricultural exports to the rest of the world, measured in value terms, rose from less than 10 percent of total production value in and before the 1940s to 13 percent in the 1960s, 20 percent in the 1970s and 22 percent in the 1980s. In terms of cropland production, exports represented less than 15 percent of the harvested acres in 1950, 20 percent in 1960, 25 percent in 1970, 39 percent in 1980 and 41 percent in 1988.[27]

Before 1960, the U.S. net agricultural trade balance was actually slightly negative. It became slightly positive as exports slowly rose in the 1960s and then accelerated in the 1970s and 1980s in response to expanding world trade opportunities. The United States became a net supplier and the top exporter of agricultural commodities to the rest of the world. More than half the increase in U.S. exports went to less developed and developing, countries and about 20 percent of the increase went to countries with centrally planned economies.[28]

The 1970s and 1980s were a period of transition and redirection of U.S. agriculture toward world markets and export trade. World economic growth, particularly in developing countries, the opening of agricultural markets in countries with centrally planned economies and a growing world population combined to expand world food demands and world trade in agricultural commodities. For example, world trade in all grains increased 2.6 times between 1961 and 1989, from 83 million tons to 212 million tons. Most of this trade growth occurred in the 1970s, when the grain trade almost doubled from 110 million tons in 1971 to 216 million tons in 1980.[29]

The emerging market situation in the 1970s created new opportunities for U.S. farmers to participate in world trade and contribute to world food supplies. The comparative advantage of U.S. agricultural lands and climate for producing food and feed grains, the growing capacity to expand production with rising crop yields, and declining unit costs of production gave U.S. farmers a competitive advantage in world markets and trade. This advantage was also enhanced in the 1970s by rising values of foreign currencies relative to the U.S. dollar. Improving U.S. crop yields and livestock productivity also helped reduce the pressure on expanding world populations to convert additional forests and wetlands to agricultural production. Under the

conditions of rapid growth in world markets, total U.S. agricultural production rose 40 percent between 1970 and 1981. Crop production rose 52 percent; crop exports increased even more, by 79 percent, and the percentage of hectares harvested that were exported rose from 25 percent to 39 percent in 1981. The total value of U.S. agricultural exports (measured in constant dollars) increased 116 percent, more than doubling as the total value of world trade increased 62 percent in the same period. During this period the U.S. share of world trade rose from 14 percent to more than 18 percent.[30]

The favorable U.S. export situation of the 1970s was abruptly interrupted in 1981 and remained depressed into the mid-1980s. The world economy weakened, interest rates rose, and the value of the U.S. dollar rose relative to foreign currencies. The 1981 U.S. farm legislation, anticipating a continuing rapid increase in export trade as well as continuing higher inflation and interest rates provided for high farm income and price supports. All these circumstances contributed to reduced competitiveness of U.S. agricultural commodities in world markets. World trade in agricultural commodities dropped 10 percent from 1980 to 1985. The value of U.S. exports (measured in constant dollars) dropped 28 percent in the same period. The volume of exports declined even more and the percent of harvested hectares exported declined to 24 percent, below their 1970 level. The U.S. share of world agricultural trade declined to 15 percent and continued downward to its recent minimum of 12 percent in 1986.[31]

Responding to this adverse export trade experience, Congress enacted legislation in 1985 that made federal agricultural policy and programs more market oriented and increased the competitiveness of U.S. farm products in world markets. This objective was achieved by lowering loan rates and by providing export assistance programs to counter subsidies used by foreign competitors. In response to these policies and to a resurgence of world trade growth, U.S. farm exports rebounded after 1986, rising almost 40 percent to approximately 145 million tons in 1988, 1989 and 1990, just 10 percent below the peak level of 164 million tons in 1980.[32]

Strengthening agricultural research became a top national priority in the 1980s, with the emphasis on increasing yields and livestock productivity and reducing production costs, consistent with conservation objectives. These research areas are important to maintaining and enhancing the U.S. capability to become fully market-oriented, expanding agricultural exports to world markets, and continuing to provide a substantial share of the world's food supplies into the 21st century. The United States also sees the need for more consistent agricultural and trade policies among the nations of the world, to assure a more stable and reliable market environment for world agricultural production and trade, and, to this end, participated in the Uruguay round of multilateral trade negotiations. The United States views progress toward consistent agricultural policies as benefiting agricultural efficiency and economic growth throughout the world.

Agriculture and the Environment: New Directions

While opportunities emerged in the 1970s to make U.S. agriculture more market-oriented and to expand exports to world markets, public concerns were growing over environmental conditions, particularly air and water pollution and the proliferation of toxic chemicals. These concerns led to passage of the National Environmental Policy Act in 1969 and enactment in the 1970s of other federal legislation for clean air and clean water, described elsewhere in this report. National efforts to improve air and water quality initially focused on point sources of emissions,

effluents, and solid wastes largely associated with urbanized and industrial areas. Agricultural activities were seen as mainly "non-point" sources of pollutants to U.S. waters (primarily from surface runoff of pesticides, nutrients from fertilizers and animal wastes, and sediment from cropland erosion). The sources of these agricultural pollutants were widely dispersed across farmlands and more difficult to regulate than emissions and effluents that are discharged from the ends of sewers and pipes directly into U.S. air and waters.

The federal government's efforts to control non-point source pollution developed slowly in the 1970s; through 1981, only one percent of federal funding to control water pollution had been allocated to non-point problems, primarily because action on point sources was regarded as more cost effective. Also solutions to non-point pollution usually involved improving land-use practices—and regulation of land use in the United States has remained largely a responsibility of state and local governments.[33] Federal government efforts to control non-point pollution therefore emphasized a voluntary, nonregulatory approach based on educational and incentive programs to encourage better soil conservation and more prudent use of fertilizers and pesticides. This approach has continued, and implementation efforts have grown to the present time. The United States has made progress in reducing and containing pollution from agricultural activities. However, more remains to be done to achieve further reductions in topsoil erosion, further improvements in animal wastes management and further reductions in the potentials for pesticide and fertilizer to run-off to surface waters or leach or percolate to groundwaters.

Control of Animal Wastes

Control of agricultural animal wastes from feedlots was an exception to this general deferral of environmental action on agricultural sources of pollution. In 1973, the U.S. Environmental Protection Agency (EPA) classified large animal-feeding operations as point sources in its policies and procedures for issuing National Pollutant Discharge Elimination System (NPDES) permits to control point-source pollutants. Under this system, large livestock and poultry feedlots that did not yet have full control of their discharges were required to obtain NPDES permits, and to control 100 percent of their discharges. Feedlots with fewer than 1,000 animals were designated non-point sources. The USDA, in cooperation with state agencies, developed educational, technical and financial assistance programs to encourage producers operating these smaller feedlots to control animal waste discharges that were polluting surface waters.

In the 19 years since the Clean Water Act was passed by EPA, 600 NPDES livestock permits have been issued. USDA technical and cost-sharing assistance for animal waste control facilities have assisted the installation of 3.2 systems per year per county for an average of 743 counties where livestock and poultry waste management was a conservation priority. This assistance has reached between 10 and 15 percent of the total livestock or poultry farms in typical livestock- and poultry-producing counties. A total of 47,000 systems were installed at an average annual federal cost of $6.7 million a year. Many other producers received education and technical assistance to improve animal waste management where facilities were ranked as lesser sources of pollution problems.[34]

Another early environmental action affecting agriculture occurred when Congress amended the regulation of pesticides under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). Pesticide regulation had been transferred from USDA to EPA under a presidential reorganization plan when EPA was created in 1970. Under the USDA, pesticide registration policy focused on the assurance of the effectiveness of the pesticides, the

proper labelling of their content and whether they were poisonous, and the establishment of tolerances for pesticide residues for food and feed. After pesticide regulation was transferred to the EPA, FIFRA was amended and expanded to mandate re-registration of all previously registered pesticide products, based on updated health and environmental protection criteria. The re-registration process has modified some pesticide registrations and removed some products from the market. Registration decisions require consideration of potential human health and safety and environmental risks, together with the economic benefits of pesticide use.[35] (For more information, see Chapter 6 on toxic substances.)

CASE STUDY

ANIMAL WASTE MANAGEMENT

The State of Wisconsin

The Wisconsin Department of Natural Resources (DNR) has inspected more than 1,000 livestock operations since 1984 that qualify as non-point sources (containing less than 1,000 animals) following the receipt of some 1,200 complaints concerning discharges of animal waste residues. When DNR finds that a discharge of significant amounts of pollutants to the waters of the state is occurring or has occurred, the owner or operator of the livestock operation is given a notice of discharge. The notice describes the discharge, suggests corrective measures and sets a given period of time for voluntary implementation. Failure to respond within the prescribed period of time leads to a DNR notice to the owner or operator to obtain a Wisconsin Pollution Discharge Elimination System permit. The permit may contain an enforceable compliance schedule to implement animal waste management practices designed by the state to control the discharge.

Since 1984, these inspections have produced 300 notices of discharge. About a third of these were purely management matters; the balance involved facility improvements. In more than 95 percent of the cases, operators responded without the need of permit action. The availability of technical assistance, information and education on management and facility operations, as well as state cost-sharing have facilitated the voluntary responses, although the threat of a permit requirement has also motivated operators to respond. When related to the total number of livestock operations, the proportion of small feedlot operations not fully meeting Wisconsin water quality standards is estimated to be between 10 and 15 percent of the total. This relatively low incidence is important to the maintenance of Wisconsin's water quality.

Pesticides and Pest Management

The Cooperative Extension Service (CES) began conducting pesticide safety training in 1965. This activity became a joint national USDA, EPA and CES effort to reduce unnecessary and excessive pesticide use and to foster responsible and environmentally sound application and disposal in response to a 1972 FIFRA amendment which mandated training for application of restricted-use pesticides. The program certified farmers, enabling them to purchase and apply restricted-use pesticides.

This program has since provided training to more than 1.5 million persons who use pesticides. Also in the 1970s, CES sought to train farmers and other pesticide users in every state in a more scientific approach to pest

control, known as integrated pest management (IPM). IPM involves careful monitoring, or scouting, of pest populations, the introduction of predators and other natural enemies of pest species (a technique called biological control), use of pest-resistant plant varieties, and, where necessary, the well-timed, precise application of agricultural chemicals. The most successful use of IPM came with crops such as cotton, fruits and vegetables where per-hectare use of insecticides had been high and consequently expensive, and pests had become resistant to chemical controls. IPM reduced both pesticide applications and costs; for cotton crops, IPM was instrumental in reducing insecticide use from 33 million kilos (active ingredients) in 1971 to 8 million kilos (active ingredients) in 1982. In 1989, 56 percent of the commercial cotton grown in the United States was professionally scouted under integrated pest management procedures.[36] The use of IPM techniques on crops other than cotton, fruits and vegetables is much less widespread.

Wetlands and Water Quality

U.S. government policy in the 1970s was changed to discourage the drainage of wetlands by withholding technical and financial assistance that had formerly been available for drainage purposes. In 1970, Congress passed the Water Bank Act, and in response USDA instituted a small-scale Water Bank Program in 1972 that provides for the protection and improvement of wetlands as habitat for waterfowl and wildlife. Since 1972, over 440,000 hectares of wetland and related adjacent areas have been contracted for protection under 10-year annual related agreements.[37]

In 1980, the federal government initiated a 10-year Experimental Rural Clean Water Program to demonstrate and evaluate the costs and benefits of long-term use of best management practices to control and reduce non-point sources of pollution of lakes, streams and groundwater from farms. The program established 20 demonstration and evaluation projects targeted to agricultural waters beds with a wide range of identified and significant agricultural non-point source water pollution problems in 20 different states. Federal program evaluations are underway, but preliminary findings suggest mixed and uneven results.[38]

Long-Term Conservation Planning

While other U.S. environmental programs in the 1970s focused on controlling point sources of pollution affecting the nation's air and water quality, agricultural programs focused increasingly on soil and water conservation. Congress enacted the Soil and Water Resources Conservation Act (RCA) in 1977, requiring the USDA to conduct a periodic national appraisal of the condition of U.S. soil, water and related resources and to develop, based on the appraisal, a long-term National Program for Soil and Water Conservation (NCP).

The first RCA Appraisal was released in 1980. Based on the findings, the NCP established the USDA's first explicit national priorities for soil and water conservation. The 1982 NCP identified soil erosion, water shortages and upstream flooding as the leading national priorities for action because these problems were not evenly distributed. For example, excess sheet and rill erosion was occurring on only a third of the nation's cropland, and was most heavily concentrated on 10 percent of the cropland, where it accounted for 50 percent of the total soil movement. Excessive wind erosion was occurring on only 22 percent of the cropland in the Great Plains states. The NCP called for targeting an increased share of federal agricultural conservation programs to critical natural-resource problem areas, increasing state and local roles in the conservation partnership with federal programs, and emphasizing more effective use of conservation tillage and other cost-effective conservation practices.[39]

In 1985, Congress updated national farm legislation with the Food Security Act (FSA). To achieve consistency between conservation objectives and those of other farm programs, the act required producers who wished to be eligible for federal farm program benefits to develop and implement conservation plans if they farmed highly erodible fields. It denied farm program benefits to persons who converted wetlands to produce agricultural commodities after 1985. Farm program benefits were similarly denied to "sodbusters" who converted highly erodible land not cropped between 1981 and 1985 to cropland production after 1985 without first implementing a conservation system.

The FSA also provided for a Conservation Reserve Program (CRP) to compensate farmers for withdrawing up to 18 million hectares of the most erodible cropland from production for 10 or more years. This initiative responded simultaneously to the need to conserve eroding cropland soils and to the rapid decline in agricultural exports. It reflected the short-term reduced need for crop production as well as the long-term outlook for increasing crop yields to satisfy future export demands.

These new initiatives were largely implemented by the end of 1990. Conservation plans had been prepared for all producers who had highly erodible fields and were participating in federal farm programs. Some 15 percent of the plans were also implemented within that time frame, although producers had until the end of 1994 to complete implementation. The CRP had withdrawn 14 million hectares of the most highly erodible and other environmentally sensitive croplands from production. Erosion on these lands was reduced by about 8 tons per hectare per year; thus the total erosion reduction on these lands amounted to nearly 650 million tons annually, or about one-fourth of the total cropland erosion occurring each year.[40]

New Priorities for Water Quality Protection

Public concerns about groundwater quality emerged in the mid-1980s and escalated rapidly in subsequent years. In the agriculture sector, public attention focused on the hazards of pesticides and nutrients and their potential for contaminating groundwater, the source of drinking water for nearly half the U.S. population. The potential for the leaching or percolation of pesticides and fertilizers into groundwater was understood, but there was little information about the actual dimensions of groundwater pollution from these agricultural sources or the degree of risk they posed for human health or the environment.

In the 1988 update of the NCP, water quality was made equal to soil erosion as a national conservation priority. A review of USDA policies and activities relating to agricultural chemicals and the environment led to a significant expansion of water quality protection activities.[41] New initiatives included expanded research on the fate and transport of agrichemicals in soils and water, improved data bases on agrichemical use, and educational, technical and financial assistance for addressing groundwater quality and surface water quality issues associated with agricultural production.[42]

The Food, Agriculture, Conservation and Trade Act of 1990 (FACT Act)

As federal agricultural programs increased their efforts to control soil erosion and protect water quality, new farm legislation—the FACT Act of 1990—was enacted. Among other changes, the FACT Act of 1990 incorporated the successful Conservation Reserve Program into an Environmental Conservation Acreage Reserve Program (ECARP). This action extended the goal of withdrawing highly erodible croplands from production. It also expanded eligibility criteria for withdrawing environmentally sensitive lands such as grass waterways, filter strips along streams, areas with saline seeps, wildlife habitat and vegetational shelter-belts which were initially included in the CRP. Special emphasis was placed on converting withdrawn croplands to

hardwood tree plantings. The original goal of the Conservation Reserve Program, the withdrawal of 16 to 18 million hectares from production, was extended for five years to 1995. Strong direction was given, targeting withdrawals to watersheds with identified water quality problems related to agricultural lands, particularly those in the Chesapeake Bay, the Great Lakes basins and the Long Island Sound area. Since 1990 an additional 680,000 hectares environmentally sensitive cropland have been approved for addition to the Environmental Conservation Reserve Program.

Authority was provided for a wetlands Reserve Program, to withdraw up to 400,000 hectares of former wetlands previously converted to cropland and to restore them to wetland conditions suitable for migrating waterfowl and other wetland-dependent species and for other beneficial uses. A Water Quality Incentives Program also authorized incentive payments to farmers to reduce agricultural sources of pollution on up to 4 million hectares of cropland while maintaining agricultural productivity. These payments are to be directed to agricultural areas not in compliance with state environmental laws. In addition, federal cost-sharing was authorized for conservation practices benefiting wetlands preservation and wildlife habitat improvement on these same lands.

The FACT Act also encourages farmers to use resource-conserving crop rotations to reduce erosion, pesticide use and commercial fertilizer applications, and to shift a portion of their cropland base to conservation uses. Participating farmers who do so are permitted to maintain the annual level of commodity-program payments that they were previously eligible to receive—even though this shift to more environmentally oriented management systems may reduce crop yields. The legislation also requires that all producers applying restricted-use pesticides keep at least a two-year record of their pesticide use, and that the records be accessible to federal agency program managers dealing with human health and environmental issues.

Except for pesticide record-keeping, all federal agricultural programs with conservation and environmental objectives are voluntary—open to all producers who qualify for the program benefits. In addition to providing incentive and cost-sharing payments, the federal government, in cooperation with the states, provides educational and technical assistance to help farmers voluntarily adopt practices and production systems that contribute to a more sustainable and environmentally sensitive agriculture. The individual states are moving similarly to encourage cultural changes in agriculture that will sustain both agricultural productivity and desirable environmental conditions.

Current Environmental Issues

The sources of risk and threats to human health and environmental quality that are related to agricultural production are generally known. The relative role of agricultural sources of pollution in the impairment of beneficial uses in surface waters is also known.[43] There is less information, however, about the distribution of certain agricultural hazards (e.g., toxicants such as pesticides) and the risks they may present. There is also a lack of consistently derived data that can be compared over time and among areas of the country. This lack of adequate information makes it difficult to quantify the impact of pollution and determine the effectiveness of control actions. This is particularly true for potential non-point-source pollutants. A 1990 report by the U.S. General Accounting Office (GAO) identifies the lack of monitoring data on both the scope and impacts of non-point sources of pollution and the effectiveness of potential solutions as one of the principal barriers impeding state and local efforts to control non-point sources.[44]

CASE STUDY
SUSTAINABLE AGRICULTURE PROJECT

Sustainable agriculture encompasses the development and use of farming practices that maximize the use of internal resources and minimize purchased inputs such as pesticides and fertilizers. The American Farmland Trust (AFT), a national nonprofit organization seeking to encourage farmers to adopt sustainable agriculture practices, began a project in 1988 to organize and monitor on-farm demonstrations of these practices in four states—Indiana, Illinois, Missouri and Michigan. AFT's project provided peer support, financial incentives and technical assistance to farmers in these states who were interested in investigating the practical applications of sustainable farming systems.

Sustainable agriculture takes advantage of a farm's biological assets to reduce the need for expensive and energy-intensive cropping inputs. Farmers who use sustainable techniques take a holistic approach to agricultural production, viewing individual cropping and livestock activities not as independent operations, but as inter-connected activities that have an impact on the health and profitability of the entire farm and the region's resource base.

AFT's Sustainable Agriculture Project had four key components: 1) establishment of a series of farm demonstration plots that compare conventional and sustainable production techniques; 2) establishment of farmer groups at the state level to facilitate the introduction and adoption of sustainable farming approaches; 3) evaluation and publication of the community, economic and environmental effects of switching to sustainable farming approaches; and 4) development of public policies to support sustainable agriculture.

Based on a study of the results from 50 demonstration plots in Illinois, Indiana and Missouri in 1989 and 1990, 36 demonstrations (72 percent) showed crop yields greater than or equal to those of the control (conventional practices) plots, nine plots (18 percent) showed decreased yields, and five plots had inconclusive results. Where farmers noted their results in terms of net profit per hectare, taking into account the cost of inputs, virtually every demonstration plot reported net profits greater than or equal to the control plots.

Some of the obvious environmental benefits of these demonstration projects include reduced soil erosion, reduced contamination of ground and surface waters, and reduced air pollution from chemicals and equipment exhaust fumes. Careful quantitative monitoring of these benefits is anticipated at a later date, in conjunction with participating universities.

USDA and American Farmland Trust (AFT) have cooperated in many sustainable farming studies. In 1988, AFT conducted a survey for USDA on farmers' attitudes toward sustainable farming systems. Over the four years of the USDA LISA (Low Input Sustainable Agriculture) program, 1,600 farmers have participated in some way—many with farm demonstration projects that show similar results as the demonstration projects conducted by AFT in the four Midwestern states.

The GAO report states that without such information, it may be difficult for public officials to convince landowners of the need for action or to target resources to the most serious problems. According to the report, landowner sensitivity over land-use regulation remains a formidable barrier to dealing with non-point pollution, and land-use requirements are more likely to be successfully applied when the public is better educated about the risks that problems such as non-point pollution pose to their health and the environment.[45]

The USDA's long and broad experience with farmers and rural people also makes it clear that once a producer or community understands that there is a problem, they are usually quite ready to address it. The U.S. Geological Survey (USGS), EPA, USDA and other federal and state agencies are cooperating in the development of risk-based assessments of environmental problems, including those related to pesticides and other pollutants from agricultural sources.

Groundwater Quality

The United States has large amounts of potable groundwater available for public and private use. Overall, the quality of the nation's groundwater is good. Virtually all the states report that most of their groundwater meets

both state and federal drinking water standards and that the quality of the groundwater is suitable for most uses.[46] Nevertheless, the groundwater of the United States is susceptible to pollution from agricultural sources, particularly nitrates and pesticides, which can leach, or percolate, into aquifers. There are localized areas where contamination from agricultural sources has exceeded maximum contaminant or health advisory levels. The EPA, USGS and USDA are working jointly with the states in developing approaches to remediating and preventing or minimizing groundwater contamination.

Pesticides. Pesticides enter groundwater by leaching or percolation through soil macropores into subsurface aquifers. Although detected in water wells and groundwater in widely distributed localities, most pesticide contamination has been at very low levels and is not a significant threat to public health, though it properly remains a concern. There are areas in several states where levels exceeding health-based criteria have been reported and have resulted in well closings and/or remediation activities. A more detailed discussion of pesticides in surface and groundwaters is contained in the toxic substances section of Chapter 6.

Nitrate in Groundwater. Nitrogen-containing fertilizers are used almost universally in agriculture. Without added nitrogen, plant growth is usually limited, at least in part, by the availability of soluble nitrogen in the soil. Because nitrogen in fertilizers is either applied in water-soluble forms or is readily converted to such forms in the soil, it is often detected as a groundwater contaminant. Nitrogen in solution is usually measured as nitrate; a nitrate-N level of three mg/l is often considered the upper level of nitrogen occurrence attributable to natural processes. Over 90 percent of 316 principal aquifers for which USGS reported nitrate occurrence had median nitrate-N levels below three mg/l . About nine percent of the principal aquifers within individual state boundaries were found to have median nitrate-N levels above three mg/l, but lower than the federal maximum contaminant level (MCL), or acceptable level, in drinking water of 10 mg/l.[47]

However, local problems occur in 13 percent of these aquifers, where 10 percent of the nitrate sample measurements exceeded the federal MCL of 10 mg/l. These areas are often associated with shallow aquifers under fragmented limestone and karst formations or under sandy, gravelly or otherwise highly permeable soils. They are also often associated with agricultural production involving crops such as corn with high levels of fertilizer use and irrigation. Some have been identified as problem areas. Such local areas occur most densely in the Great Plains states, but they are also found in other states.

Very little quantitative information exists on nitrate trends in groundwater. Available data indicate very slow changes in median nitrate levels except in problem areas where more rapid rising levels and lateral extensions have been reported. There is also great variance in sample measurements of nitrate in wells and groundwater between years, seasons and shorter periods; for different depths of sampling; and for different climates, soils and drainage conditions. As a result, it is difficult to develop reliable trend data or prediction equations for the expected level of occurrence of nitrate in groundwater and wells.[48]

A large amount of work has been published on the role of nitrate in plant nutrition, but research and development on ways to prevent nitrate leaching to groundwater are still needed. Recent studies have shown that maintaining current productivity levels of corn (maize), for example, requires high levels of nitrate in soil water at critical periods during the development

of the corn plant.[49] During most of the growing season, there is small risk that significant leaching will occur. The challenge is to develop technology that controls the formation of nitrate from fertilizer according to a release schedule that accommodates the crop's schedule of needs, and also assures that nitrate left in the soil at the end of the crop growth cycle is minimal, or that means for its removal by cover-crop scavenging or by microbial denitrification are applied. This research is being pursued by federal and state agencies.

Nitrate in Drinking-Water Wells. A 1990 government survey of drinking-water wells in the United States found 2.4 percent of private domestic and 1.2 percent of community water supply drinking-water wells with nitrate-N above the MCL nationwide. Those percentages convert to 254,000 out of 10.5 million private wells and 1,100 public system wells out of 94,600 nationally.[50] Another statistical survey of drinking water wells, conducted by the Monsanto Agricultural Products Company in alachlor sales areas in 26 states, reported that five percent of the sampled wells had nitrate-N above the MCL. On farmsteads, however, the survey found this frequency to be closer to 10 percent.[51]

Contamination of drinking-water wells by nitrate or pesticides above the MCL or the health advisory level involves an immediate threat and risk to the health of users of such well water. Well contamination is often associated with farmstead sources, such as abandoned and active feedlots, barnyards, buried organic materials, silos, septic systems or pesticide activities. Such wells can also serve as a pipeline to the aquifer for direct delivery of bacteria, nitrate and pesticides to groundwater. Thus finding and remediating contaminated drinking-water wells is among the highest short-term agricultural priorities. A pilot Farmstead Assessment System has been successfully tested and evaluated in Wisconsin and Minnesota for assessing the potential of well contamination from farmstead sources. It provides the farmer with a series of basic integrated worksheets to use in evaluating farmstead-specific pollution potentials. Federal agencies are working to extend this assessment system into each of the states, for use in counties where it can be effective in the control of farmstead pollution sources. This technology transfer includes guidance on how to target activities where there is a significant potential for drinking-water well contamination from farmstead sources.

Animal Wastes. Animal wastes are a source of nitrate contamination when improperly managed. The most general solution is to recycle the wastes on cropland and grassland. The knowledge and technology for effective animal-waste management is generally established and understood. The main need is to see that the available knowledge and technology is effectively applied where animal-waste storage systems are inadequate, leaking, or overflowing, and where recycling on the land may be improper—such as applying excessive quantities or spreading on frozen soils. Where new or improved waste management facilities are needed, financial assistance often is an effective incentive for action.

Except for the rate and timing of manure applications to croplands, recycling of animal wastes on cropland and grassland should not in itself create a nitrate leaching problem since the nitrate content of manures should average less than that removed by the crops. It is, however, an important component of total nitrate use and management. Recent studies have shown that farmers often were not taking proper account of the nitrate content of recycled manure and therefore, were adding excessive amounts of commercial fertilizers. Technology has been developed and is being rapidly extended to

farmers to take proper account of residual nitrogen in the soil in managing manures and commercial fertilizers.

Surface Waters—Rivers and Lakes

Rivers. In their 1990 water quality assessments, 42 states provided information on sources of pollution in their rivers and streams. Agricultural activities were by far the largest source of pollution and were associated with 60.5 percent of impaired stream kilometers. By comparison, municipal sources were associated with 16.4 percent of impaired stream kilometers, hydrologic/habitat modifications with 14.6 percent, resource extraction with 14 percent, storm sewers/runoff with 10.6 percent and industrial sources with 9.1 percent. (The percentages are not additive throughout this section, since more than one source often contributed to impaired waters.)

Leading pollutants from all sources in rivers and streams included siltation, associated with 36.2 percent of impaired kilometers; nutrients such as phosphorous and nitrogen, associated with 27.9 percent; and organic enrichment, associated with 25.7 percent. Non-point sources such as agricultural production are leading contributors of these pollutants.

Lakes. Thirty-five states provided information on sources of pollution in their lakes and reservoirs. Agricultural activities were again the leading source, and were associated with 56.9 percent of impaired lake hectares. Other leading sources in lakes include hydrologic/habitat modifications, associated with 40.1 percent of impaired hectares; storm sewers/runoff, associated with 27.7 percent; land disposal, associated with 24.1 percent; and municipal dischargers, associated with 16.9 percent.

Of the leading pollutants in lakes, nutrients were associated with 32.1 percent of impaired lake hectares; organic enrichment with 19.2 percent; suspended solids with 13.1 percent; noxious aquatic plants with 12.7 percent and siltation with 12.6 percent. Metals were associated with 47.9 percent of impaired lakes hectares, but were primarily attributed to mercury in fish tissue in one state.[52]

Nitrate. Major sources of nitrate in rivers and lakes include agricultural runoff, atmospheric deposition, and municipal and industrial wastes and runoff. The national average (median) level of nitrate-N concentration in U.S. rivers and streams was reported to be 0.41 mg/l in 1981. This compares with the optimum nitrate-N level for aquatic life in rivers and streams, which is considered to be one mg/l.[53] Nitrogen concentrations in streams monitored across the nation between 1974 and 1981 increased at 116 stations, decreased at 27 stations, and remained unchanged at 240 stations (62 percent).[54] The use of nitrogen fertilizer in the United States reached a peak level in 1981. Since then it has remained relatively stable at about 10 percent below the 1981 peak level. The available data indicate that annual median levels of nitrate-N seldom exceed one mg/l. However, there can be wide transient fluctuations; peak concentrations occur in the spring and early fall in places where rainfall and runoff are normally elevated in those periods. Transient elevated levels of nitrate-N also can occur as streams pass through urbanized areas and livestock-producing areas with significant waste discharges or runoff with elevated nitrate concentrations.[55]

In Iowa, where intermittent elevated nitrate concentrations have affected about 45 community water supply systems, community water works have commonly dealt with this problem by mixing groundwater with surface water to reduce nitrate-N concentrations in drinking water to levels below the MCL. In 1990, the city of Des Moines, Iowa, determined that it needed a special facility to reduce intermittent elevated nitrate-N in its water supply

because recent occurrences were taxing the system's capacity to dilute such waters.[56]

Increasing trends in nitrate concentration were most frequent in the eastern half of the United States, and were strongly associated statistically with fertilized land as a percent of basin area, livestock population density and feedlot activity.[57] Conversely, high levels of atmospheric deposition, associated with increases in nitrous oxide emissions from electric utilities and highway vehicles, were a suspected cause of increased nitrate concentrations in surface water in the Ohio, Mid-Atlantic, Great Lakes and Upper Mississippi Basins. Overall, nitrogen trends to 1981 appeared to be related more to non-point sources than to point sources.

Phosphates. Phosphorus, in the water-soluble form of phosphates, is important for plant growth, and is also a common water pollutant. It, along with nitrogen, is associated with excessive aquatic plant growth. Phosphates enter surface waters from waste water treatment facilities and other point sources and in surface runoff, especially from land to which fertilizers have been applied. Between the early 1970s and 1981, phosphorus has generally been reduced in surface waters, particularly in areas such as the Great Lakes and Upper Mississippi River basins, where reductions in suspended sediments have also occurred. Unlike nitrate, phosphate in coastal waters remained stable or declined in most regions. The Gulf Coast and Pacific Northwest basins were exceptions, where phosphorous loads increased during that same period in association with increases in sediment loads.[58]

The overall reduction of phosphates in U.S. waters during the 1974 to 1981 period is attributed to decreases in point source discharges, which include the large feedlots that were classified and regulated as point sources after 1976. Where increases occurred, they were attributed to non-point sources, particularly agriculture. This is indicated by the statistical association of increases in phosphate concentrations with increases in agricultural fertilizer use, feedlots, cattle population density, and increased delivery of sediment. Phosphate ions attach readily to the soil particles that end up as sediment in lakes and streams as soil erodes from agricultural fields. However, since 1981 soil erosion and related delivery of sediment to lakes and streams has been reduced by 25 percent through the Conservation Reserve Program and other programs oriented to erosion control. Further reductions are expected after the end of 1994 as the erosion control objectives of the conservation compliance program become fully effective.

Fisheries. The 1982 National Fisheries Survey was statistically designed to provide a baseline for the nation's water quality and related limiting factors in relation to fish communities.[59] The survey included all flowing waters in the contiguous 48 states, including main-stem impoundments. Its principal finding was that the nation's waters, "to a large degree," are able to support viable fish populations but they are "widely affected by pollution, especially from non-point sources, and by problems of water quantity, primarily natural low flows." Water quality was a limiting factor to optimum condition in 56 percent of the sampled waters. Twenty-nine percent were affected by "probable" agricultural sources of pollution; these were major concerns in 17 percent of the sampled waters. Turbidity from all sources was the leading factor affecting 34 percent of all waters; nutrients from all sources affected 13 percent of all waters and pesticides affected 7.5 percent. Apart from the water quality of rivers, adequate water quantity to support fisheries resources is variable. Channelization and dam construction for irrigation purposes has modified the natural water flow of some rivers. This has affected freshwater fish and certain runs of salmon in California and the Pacific Northwest.

Along riparian waterways, unmanaged grazing by cattle has resulted in destruction of freshwater fish and waterfowl habitats. The intensity of agricultural activities in coastal areas varies widely among regions. These activities can affect fisheries stocks in coastal and estuarine areas. Approximately 70 percent of commercially and recreationally important fish and shellfish spend parts of their life cycle in these areas. (For further information see the oceans and coastal resources section of Chapter 6.)

Pesticides. Pesticides, including herbicides, and their breakdown products are commonly found in low concentrations in surface waters. Pesticides enter surface water in runoff from agricultural lands and in rainfall as dissolved aerosols. A combination of increasing regulatory restrictions on and decreasing effectiveness of organochlorine insecticides, such as DDT, chlordane and dieldrin, has led to a dramatic decrease in their use since the mid-1960s and an erratic decrease in their occurrence in water and sediment samples since 1975. However, because organochlorine insecticides degrade very slowly compared to some of the other pesticides, their residues continue to be found in sediments and can be problematic when they are stirred up significantly. (For more information, see Chapter 6 on toxic substances.)

Estuaries

Estuaries are particularly vulnerable to pollution because they serve as sinks for pollutants from a wide variety of point and non-point sources, including agriculture, that are transported downstream by rivers and their tributaries. Agricultural sources of pollution were associated with 18.2 percent of the estuarine waters that are impaired by all sources of pollutants, according to reports by 15 of the 23 coastal states. For comparison, municipal sources were associated with 34.6 percent of impaired estuarine waters; storm sewers and runoff with 30.4 percent; and land disposal of solid and other wastes, 19.3 percent. (These percentages are not additive.)

Nitrogen and phosphorus from all sources, including agriculture, caused 54.7 percent of the impairment. Other pollutants often associated with agriculture include organic enrichment, associated with 31.3 percent of impaired waters; suspended solids (7.8 percent); siltation (5.2 percent); and pesticides with 1.8 percent.[60]

Analyses available from 1982 for 24 estuaries along the East coast indicate that the nitrate discharges from agricultural sources within coastal counties contributed less than 10 percent of the total nitrate loadings to the 24 estuaries. However, for individual estuaries this percentage varied from less than one percent to 60 percent.[61] The absolute amounts of nitrate loadings likewise varied over a wide range, from three tons per year to 12,000 tons per year. For seven of the 24 estuaries, upstream sources above the coastal counties contributed between 64 and 95 percent of the nitrogen loadings. Thus, inland agricultural sources can be an important source of nitrate loadings to some estuaries.

Phosphate loadings to the 24 East coast estuaries were less than 25 percent of the total nitrate loading. Agricultural sources in coastal counties were generally minor contributors to the phosphate deliveries to these estuaries; in only five cases did they exceed five percent. Upstream sources, however, including agricultural lands, were major contributors in six of the 24 estuaries, contributing between 25 and 98 percent of the loads.

Wetlands

Among the most sensitive environmental issues for agriculture is the protection of wetlands from conversion to other uses. Much of the more than 40 million-hectare loss of wetlands in the conterminous United States since the nation was established was due to conversion to agricultural use. Wetlands, once drained, are often among the most productive lands for

agricultural crops. Since wetlands were regarded largely as nuisances, wastelands, habitats for pests and threats to public health from colonial times until recently, their drainage and conversion to agriculture was considered to be desirable by many U.S. communities. Some of the original wetlands converted to agricultural use have been shifted into urban and other more developed uses in response to U.S. population growth and urbanization. Today, about 24 million hectares of the cropland used in the United States could be classified as former wetlands.

A rapid loss of wetlands in the conterminous United States between the mid-1950s and mid-1970s, approximately 4 million hectares in 20 years, focused new attention on their benefits for wildlife habitats, waterfowl populations, fisheries, water quality improvement and recreation use. This loss averaged 183,000 hectares a year, after offsetting for the 800,000 hectares of new wetlands created in the same period. These net losses also largely resulted from the conversion of wetlands to agricultural production.

In the 1970s, national policies and programs combined with low commodity prices to slow the loss of wetlands and encourage their restoration where they had been previously converted or damaged. Federal assistance for the drainage of wetlands was largely prohibited, and technical and financial assistance was provided for wetland improvement. Current farm policies now withhold benefits of farm programs from producers who convert wetlands to crop production and other uses. The 1990 FACT Act further provides for the withdrawal of up to 400,000 hectares of former wetlands previously converted to cropland and their restoration to wetland conditions under the Wetland Reserve Programs. A recent U.S. Fish and Wildlife Service assessment indicates that over the nine-year period from the mid-1970s to the mid-1980s, the net amount of wetlands declined by one million hectares—approximately 116,000 hectares per year.[62] More recently the USDA National Resources Inventory statistical sampling and analysis estimated that wetland losses were approximately 48,000 hectares per year between 1982 and 1991. This inventory covers about 75 percent of the land mass in the lower 48 states.[63]

Wildlife

Increasing public and scientific interest in wildlife protection has focused attention on agricultural activities that can adversely affect wildlife and wildlife habitats. The conversion of wetland for agricultural use is a particularly clear example, since such conversion significantly reduced habitats for waterfowl and many other species. Conversely, there have been substantive gains in some wildlife populations over large areas of the United States as private and public land has been managed to increase habitat. Reforestation in the eastern United States has resulted from the conversion of cropland to natural uses due to economic conditions which provided private landowners a disincentive to farm or harvest for firewood. However, many other agricultural activities have negative effects on habitats, including the use of agricultural chemicals, irrigation, drainage, double-cropping, increased field size and the improvement of cultivated plant varieties. The replacement of wild forests with managed timber stands or croplands and of wild pastures with croplands and managed pastures, and widespread use of monocultures reduced the diversity of native plant life and with it the diversity of habitats for a variety of plant and animal species.[64] (For more information, see Chapter 6 on biodiversity.)

Since 1930, however, increased agricultural productivity has been responsible for maintaining the area of U.S. cropland used at approximately 160 million hectares as the U.S. population doubled and farm exports to the rest of the world increased even more rapidly. This intensification of agricultural production has made it possible to avoid further expansion of cropland used and further conversion of forest and grassland habitats to crop

production. This is an indirect benefit of agriculture to the protection and maintenance of the nation's remaining natural ecosystems. The reduction in harvested cropland since 1930, due to productivity improvements, has likewise benefited wildlife species. The creation of edge effects and new food sources in cultivated agricultural areas has likewise benefitted some species of wildlife.

During the past decade, U.S. agriculture has become more sensitive to the public interest in the protection and enhancement of wildlife, and has generally responded with adjustments in programs and practices. Most of these changes are normally not inconsistent with agricultural objectives. For example, the federal conservation reserve program and related cost-sharing incentive have encouraged and assisted the establishment of the following wildlife conservation practices on farmlands since 1985: 760,000 hectares of wildlife plantings, over 5,000 hectares of wildlife shallow water areas, 6,000 hectares of wildlife food plots, 50,000 hectares of permanent wildlife habitat, and 36,000 hectares of shallow water areas for wildlife. Other federally assisted conservation practices, designed primarily for agriculture or forestry purposes, also provide wildlife benefits: over 12 million hectares of tame and native grass plantings, 840,000 hectares of forest plantations, and 328,000 acres of field and farmstead windbreaks.[65] Many states are encouraging and assisting similar practices for wildlife enhancement on farmlands.

Climate Change and Other Atmospheric Considerations

This report discusses general climate change issues in Chapter 6. Sensitivity of the global environment to effects of changes in the composition of greenhouse gases in the atmosphere is, however, not a new issue to agriculture. In the past two decades, agricultural climate-change concerns have increasingly focused on two basic questions: (1) how emissions from agriculture, grazing and forestry may affect the composition of greenhouse gases, and (2) how the secondary effects of increasing greenhouse gases, i.e., changing climate patterns, may potentially affect agriculture, forestry and other natural resource systems. There are four main areas of concern: (a) ultraviolet-B radiation and its effects on crops and animals; (b) low-level ozone and its effects on agriculture; (c) effects of acid deposition and ozone on forests and crops, and (d) the effects of temperature and moisture shifts on forest, range and agricultural ecosystems.

Ultraviolet-B Radiation. Since 1972, USDA has participated in research programs to assess the potential hazards to plants and animals of increased UV-B radiation that might reach the Earth's surface as a result of ozone being depleted in the stratosphere. Research began increasing in 1989 when additional support was provided by Congress. Scientists developed studies to understand what happens when high levels of UV-B radiation damage the surface of various crops. Emphasis has focused on soybeans and cucumbers; under high UV-B levels in the laboratory, growth and development are inhibited in both crops. The most significant and consistent observed effect of elevated UV-B, however, has been an increase in enzymes and other UV-absorbing substances in the surface cells of the plant, which serve as an optical screen to exclude UV radiation.

Low Level Ozone. Ozone acts as a filter for ultraviolet radiation in the upper atmosphere, or stratosphere, but is a pollutant toxic to plants in the lower atmosphere, or troposphere. Some recent studies have begun to consider ozone in the context of global climate change. Combined effects of ozone and elevated carbon dioxide, for example, are being investigated because elevated carbon dioxide usually stimulates plant growth, whereas the effects of ozone suppress growth. Similar studies have focused on the combined effects of ultraviolet-B radiation and ozone. Increasing emphasis is being

placed on developing plant process models that incorporate influences such as ozone, UV-B radiation, carbon dioxide and combinations of these.

Acid Deposition and Ozone. Public concern about acidic deposition as an environmental problem can be traced to Scandinavia in the mid-1950s, where studies focused on acidification of precipitation and surface waters. These concerns increased from the mid-1970s to the early 1980s as damage of uncertain origin was observed in some widely distributed stands of commercially important trees. As research findings became available, it was discovered that many different stresses were interacting to cause forest declines. Thus, the research had to be broadened beyond acid deposition.

One of the most encompassing conclusions from the many studies completed during the past decade is that most forests in the United States do not show unusual visible symptoms of stress, marked decreases in rate of diameter or height growth, or significant increases in mortality specifically attributable to acidic deposition. Only forests frequently exposed to highly acidic cloud water, or in areas with major sources of pollutant emissions, exhibit substantial evidence that acidic deposition is a significant contributing factor to observed forest health problems.

Climate Change Effects. As the issue of global climate change, and more specifically global warming, has evolved over the past few years, the U.S. government has supported programs to respond to the questions raised and to provide a broader understanding about how farming, grazing and forest ecosystems affect the emissions of greenhouse gases as well as how potential climate changes might affect farming, grazing and forest ecosystems. Government-sponsored global climate change research programs are examining the basic processes related to how various ecosystems, at the regional scale, may respond to changes in temperature and moisture patterns and cycles. Some studies are proceeding to measure the amounts of greenhouse gas emissions from various cropping and forest management systems. Other studies are underway to determine the capability and methods for sequestering carbon in crop, range and forest soils. Federally sponsored programs are also developing the capability to project potential responses to changes in temperature, moisture and storm frequency at the regional scale, and to provide information needed to support planning and management for individual farms or forests. Regional response information ultimately will be linked to general circulation models, but this linkage is not yet being addressed.

Biotechnology

Biotechnology promises growing opportunities for agriculture and the environment. Agriculture biotechnology is viewed as the most promising approach for ensuring profitable and sustainable food, fiber and forest product industries in the future. Considering the rapidly growing world population and the pressure of its food requirements on the Earth's resources, biotechnology offers many potential avenues for increasing food supplies rapidly while minimizing the impact of expanded production on land use, resources and the environment. Environmental concerns about biotechnology center on the uncertainties associated with altered organisms that may be released into the Earth's ecosystems. (See Chapter 6 for more information.)

Since the mid-1970s, the rapid development of biotechnology has offered agriculture a new set of tools with great promise. Federal agencies have increasingly supported biotechnology research at government laboratories and at U.S. colleges and universities. During the 1980s, a regulatory program based on existing statutes was developed for testing potentially useful new agricultural products developed through biotechnology,

such as plant varieties and veterinary biologicals. This program provides technical oversight to ensure that biotechnology products are developed safely and tested in ways that protect the environment and public health. In recent years much public funding has been directed toward using biotechnology to make U.S. agriculture more compatible with the environment. Two ongoing biotechnology activities involving plant species are to enable non-leguminous plants to fix nitrogen and to improve disease and pest resistance of crop plants.

Endnotes:

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PART III

ENVIRONMENTAL CONDITIONS AND MANAGEMENT IN THE UNITED STATES

CHAPTER

5

ENVIRONMENTAL LAW AND INSTITUTIONS

Overview

■

Constitutional Framework

■

Statutory Framework

■

Current Developments

■

International Dimensions

OVERVIEW

This chapter traces the constitutional sources of authority for environmental laws and institutions in the United States, and briefly describes their evolution from a series of unrelated statutes to a large, inter-connected, multilevel legal system encompassing resource protection, environmental health, biological conservation, pollution control and prevention, and environmental policy and management. The set of environmental laws and regulations now in force at the federal level alone comprises many volumes; a comprehensive review of the history and complexity of U.S. environmental law and institutions would require additional volumes.[1] This chapter thus necessarily provides only an overview and a glimpse of anticipated future legal and institutional developments.

The nation's first federal environmental laws and policies emerged near the end of the 19th century, when Congress authorized the establishment of national forest preserves and national parks, and established penalties for dumping refuse into navigable waters of the United States. Until the mid-20th century, federal and state environmental laws continued to address specific disparate matters such as park designations, wildlife preservation, soil conservation, public health and resource management on public lands. The development of environmental law following World War II refined the established federal roles of resource conservation, expanded environmental research and technical assistance, and buttressed the role of the states in setting standards for regulations to protect public health. At the close of the 1960s, rapid growth in environmental consciousness ushered in a series of new federal laws and institutions designed to restore and maintain the quality of the U.S. environment, through comprehensive regulation of air and water pollutants. They also established a process for early analysis and review of proposed federal actions that might significantly affect environmental quality. In the 1970s, additional broad federal laws to control toxic chemicals and hazardous wastes and to protect animal and plant species were added to the list. Existing federal institutions expanded their environmental efforts and new federal institutions were created to oversee and implement these laws and policies.

In the 1990s, a new strategy is being added to improve the effectiveness of existing laws and to expand the ways in which the U.S. goal of protecting and maintaining the nation's environmental quality can be achieved beyond the strict enforcement of statutes and regulatory standards. This strategy is exemplified by the use of free markets and economic incentives to enhance efficiency in energy consumption and industrial design, and to reduce or eliminate the generation of hazardous wastes and other pollutants. This strategy also supports a more holistic, long-term approach to both domestic and international decision-making for natural resource management and environmental protection, in anticipation of the many common environmental issues facing the United States and other nations in the 21st century.

CONSTITUTIONAL FRAMEWORK

In the legal system of the United States, the overarching source of authority for environmental law is the national Constitution. The Constitution establishes and demarcates the powers of the three branches of the federal government—the legislature (Congress), the executive branch (the President and the federal agencies), and the judiciary.[2] It also provides the foundation for the relationship

between the federal and state governments. The "separation of power" among the three federal branches and the relationship between the federal government and the states, provide the framework in which the federal and state governments enact, implement and enforce the environmental protection laws.

Several constitutional provisions form the basis for federal authority in environmental law. The Constitution grants to Congress the power to "make all needful rules and regulations respecting the Territory or other Property belonging to the United States." This provision underlies federal land management and regulatory authority for the one-third of the United States that is directly owned or managed by the federal government. (See the section of Chapter 6 on Land and Mineral Resources.)

Federal authority over public and private parties in the field of the environment is also premised on the "Commerce Clause" of the Constitution.[3] The "Commerce Clause" provides Congress with authority to regulate interstate and foreign commerce and commerce with Indian tribes.[4] The "Commerce Clause," and its broad interpretation by the federal courts, empowers Congress to enact environmental statutes applicable to states, municipalities, and private enterprise.

Other constitutional provisions define and circumscribe the federal government's regulatory powers in environmental matters. The "Supremacy Clause" of the Constitution gives federal law precedence over conflicting state laws, while leaving room in many circumstances for states to establish more stringent regulations than those adopted at the federal level. Several major federal environmental statutes provide incentives for state governments to develop environmental programs that parallel the requirements of federal law. Such cooperative regulatory programs ensure a key role for states in environmental law enforcement and policy-making, while reserving the federal government's authority to determine whether the state programs meet the federal requirements.

The Constitution prohibits the taking of private property without just compensation. In some cases the U.S. Supreme Court has determined that environmental regulation can require the payment of compensation for the taking of private property.[5] Constitutional provisions protect the rights of individuals by requiring that certain procedural safeguards be followed before sanctions for violations may be imposed.

The Constitution's spacious framework permits federal and state enforcement programs to operate in tandem with actions brought by private citizens to enforce environmental statutes against private or public entities whose violations of those statutes have injured them.[6] Federal environmental laws combine waivers of sovereign immunity with private citizen enforcement provisions to a greater degree than nearly any other body of American law or any other country's national environmental legislation. Many federal and state environmental statutes extend private litigants' rights far beyond the tort liability that exists at common law in the various states. These environmental statutes allow any person to assert a private cause of action to enforce statutes and administrative processes that did not exist under common law. Furthermore, the traditional U.S. rule that each party bears its own costs of litigation has been altered by statute in some environmental matters and allows recovery by successful private litigants.[7]

A number of constitutional provisions, although not specifically directed at environmental concerns, safeguard rights to participatory democracy, including protection of freedoms of speech and assembly, freedom of the press, the right to vote, and to petition the government for redress of grievances. Thus, the U.S. legal system offers many opportunities for public participation in the formulation of environmental laws, the review of proposed

rules and regulations for implementing them, and their enforcement through the judicial process. In keeping with this basic constitutional structure, the U.S. Constitution provides no "right" to a healthy environment.[8] In the U.S. experience, it is the reality of complex decision-making, the balancing of environmental goals with other social needs, and the enforcement of environmental standards created through law, that determine environmental quality. Accordingly, the United States is constantly working to translate environmental priorities into enforceable legal requirements.[9]

STATUTORY FRAMEWORK

At the federal level, Congress enacts environmental laws pursuant to its constitutional powers to regulate interstate commerce and to control activities on federal lands. Once enacted, those laws are implemented by the executive branch, whose authority is both granted and limited by the language of the laws and the Constitution itself.

The Beginnings of Modern Environmental Law

Federal legislation for environmental conservation and resource management dates back to 1872, when Congress established Yellowstone, the nation's (and the world's) first national park, and to 1891, when Congress authorized the President to establish forest reserves in the public domain lands. Laws establishing other national parks, national forests and interstate water compacts, as well as various other federal conservation and management authorities predated the enactment of the post-World War II environmental laws.[10] But in the postwar era, Congress charged the federal agencies with a broad range of new responsibilities for protecting public health and resource values. For example, Congress in 1947 recognized the need for registration and safety requirements to limit health risks from agricultural pesticides.[11] Congress also directed the Secretary of Agriculture in 1960 to develop and administer the national forests for multiple use and sustained yield.[12] In 1964, in recognition of the public's desire that some federal lands remain "unimpaired for future use and enjoyment as wilderness," Congress created the National Wilderness Preservation System.[13]

For water and air resources, however, the federal role remained primarily one of research and provision of technical assistance. The states undertook responsibility for setting-standards while the federal government provided grants to states that adopted specific measures to control pollution.[14] The continued reliance on states for setting standards stemmed in part from federal recognition of the historic activity of states and municipalities in protection of local resources. Meanwhile, local governments expressed concern about the quality of life, including environmental quality, through intensified activity in urban and regional planning.

The Environmental Revolution: 1970s and 1980s

The explosion of environmental consciousness signaled by Earth Day, April 22, 1970, caused the national government to realize that general, program-oriented statutes were not providing sufficient environmental protection. Congress, concerned that the environment in its totality and its constituent elements needed greater protection, enacted two basic types of environmental statutes in the 1970s and 1980s: general environmental assessment laws, and specific resource protection statutes to protect environmental "media" (such as air, water and coastal resources) or control specific types of pollution (such as hazardous waste and toxic substances). The new resource-specific statutes provided for judicial remedies, including civil and criminal enforcement.

New Institutions

Congress and the executive branch also created new federal institutions with missions that paralleled the two types of statutes. The Council on Environmental Quality (CEQ) was established in 1970 to review, appraise, and make recommendations to the President regarding the programs and activities of the federal agencies as they affected the quality of the human environment.[15] Also in 1970, President Richard Nixon created two new federal agencies: the U.S. Environmental Protection Agency (EPA), and within the U.S. Department of Commerce, the National Oceanic and Atmospheric Administration (NOAA). EPA was charged with implementing a number of the resource-specific statutes, primarily those that regulate pollution of air, water and other environmental media. NOAA was given responsibility for management and monitoring programs relating to coastal and marine fisheries and atmospheric sciences and forecasting. Other federal institutions were also given administrative enforcement authority.

The new statutes also stimulated the development of new institutions at the state level. A number of federal statutes specifically encouraged parallel implementation through federally approved state programs, with significant enforcement responsibilities given to the states. Many states developed their own departments of environmental protection, councils on environmental quality and like institutions, and several of these institutions developed innovative environmental programs that served as models for other states and for the federal government as well.

Public Participation

An important feature of these new statutes was their strong emphasis on public participation. This was achieved both by providing for public involvement in the administrative development of regulations and standards,[16] and by creating rights of action that enabled private parties to obtain judicial review of rules, to challenge their application, to enforce them against private parties and, in specified circumstances, against the government.[17] Public participation in development of regulations and standards includes notice of, and opportunity to comment on, proposed rulemaking, as well as access to planning documents, environmental assessments and other relevant information, participation in public hearings and dialogues with the responsible government officials. Public participation in the judicial review and enforcement process includes, in many instances, the participation not only of individual members of the public, but also of groups. In response to these opportunities for participation, there has been a tremendous growth in the number and membership of nongovernmental environmental organizations. These entities have developed their own expertise, retained professional staff, prepared their own reports and proposed legislation, and have become actively involved in the development and implementation of environmental laws and regulations at local, state and national levels.

Environmental Assessment Statutes

Foremost among the environmental assessment statutes enacted was the National Environmental Policy Act of 1969 (NEPA).[18] NEPA requires analysis of the environmental consequences of most proposed major federal agency actions. The Endangered Species Act (ESA), enacted in 1973, is another statute with significant environmental assessment components.[19] The ESA, among other things, requires federal agencies proposing to authorize funds or carry out actions affecting the environment to consult with the Departments of Commerce or the Interior (for their expertise in species preservation) to determine whether a proposed project would jeopardize species listed as threatened or endangered under the act or would result in the destruction of habitat deemed critical to the survival of listed species.[20]

The environmental assessment components of these statutes do not directly reach actions taken by private parties. Instead, the statutes require federal agencies to undertake certain evaluations or considerations before granting permits, licenses or other permissions to private parties if the pending action could result in adverse effects on the environment. Thus, if a private party seeks to undertake an activity for which federal permission is required, the federal agency may be required to examine the environmental impact of the private proposal, including its impact on endangered species; the agency would also have to consider alternatives prior to granting the permit.[21] In such cases the responsible federal agency may require the applicant to conduct environmental studies as part of the application process, and to submit the results of those studies to the agency for its use in meeting the environmental review requirements.

Although the United States does not as a matter of law require private parties, other than those seeking federal permits, to evaluate the environmental impacts of their actions, a number of legal mechanisms have been instituted that encourage them to do so. Many of the resource-specific statutes contain reporting requirements, such as those requiring firms to report the amount of certain substances emitted into the environment. Some firms are also required to conduct environmental audits and to disclose information concerning their environmental activities. For example, the Emergency Planning and Community Right-to-Know Act requires public disclosure of toxic releases.[22] Public participation in environmental assessments, and public access to the results of such assessments and to other environmental information, is an important component of United States environmental law.[23]

Resource-Specific Statutes

In the 1970s and early 1980s, Congress enacted a series of statutes aimed at protecting particular environmental media, including air, water, coastal areas, fisheries and marine mammals, and endangered species. Congress also enacted statutes controlling specific classes of environmental pollutants, including toxic and hazardous wastes. The new statutes contained enforcement provisions that enabled the federal government to obtain injunctions against polluters, to recover damages and civil and criminal penalties, and to put criminal violators of environmental laws in jail. Many of these statutes also enable private citizens, in certain circumstances, to enforce laws against polluters. Among the most comprehensive of the resource-specific statutes are the following:

- *The Clean Air Act* provides for the adoption of uniform federal standards for specified air pollutants. It places responsibility with the states for developing and implementing plans for attaining these standards, subject to federal plan approval, and requires controls on emissions from motor vehicles and new sources of pollution.[24]

- *The Clean Water Act* imposes technology-based and water-quality-based effluent standards, and requires "point source" dischargers of pollutants to waters of the United States to obtain federal permits incorporating these standards.[25] Industrial sources are required to limit their pollution to the level achievable through implementation of "best available technology." Municipal sources must attain secondary levels of treatment or better unless more stringent requirements are necessary to meet water quality standards. Other key components of the act establish a construction grant program for municipal sewage treatment plants, protect wetlands by prohibiting persons from dredging and filling in coastal areas and along navigable waters without a permit, and prohibit discharges of oil or

hazardous substances into navigable waters. Pollution from "non-point" sources, and protection of groundwater resources, have not been addressed comprehensively to date.

- *The Resource Conservation and Recovery Act* provides for the control of certain solid and hazardous wastes. For hazardous wastes, the act establishes a "cradle-to-grave" regulatory program aimed at ensuring proper waste management, monitoring and disposal. The act encourages proper management of municipal and non-hazardous solid waste through the provision of federal grants to states that establish federally approved programs to improve their management of such waste.[26]

- *The Toxic Substances Control Act* establishes federal authority for comprehensive testing and monitoring of potentially toxic chemical substances and mixtures of chemical substances.[27] Important components of the act include authority: to review new chemicals before they are manufactured or imported, to require testing of existing chemicals, and to prohibit or limit, on the basis of risk-benefit analyses, the manufacture or use of specific chemicals.

- *The Endangered Species Act* requires environmental and biological analysis of potential effects on endangered species, and also imposes substantive requirements to promote species preservation.[28] The act requires federal agencies to ensure that their actions are not likely to jeopardize any listed species, and prohibits the taking of listed species by private as well as public entities. In addition, portions of the statute implement the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), by banning trade in plant and animal species threatened with extinction, and by strictly regulating trade in species that may become threatened if not otherwise protected.

- *The Superfund Law* mandates cleanup of abandoned hazardous waste sites, and holds private parties liable for cleanup costs and for damages to natural resources, even where waste was left at sites prior to the enactment of the statute.[29] The act establishes a fund (called "Superfund"), financed primarily by taxes on petroleum products and chemical feedstocks, which can be used to underwrite the costs of cleanup. In the event a cleanup is financed by the fund, the government can seek to recover the costs from polluters. The act creates a new institution, the Agency for Toxic Substances and Disease Registry, which conducts health studies in connection with abandoned waste sites. The act's Community-Right-To-Know provisions (discussed in the Chapter 6 section on toxic substances) gives the public access to information on the magnitude of toxic emissions, and thus spurs industry to reduce those emissions faster than the law requires.

A significant feature of several of the resource-specific statutes is their attempt to implement the "polluter pays" principle. Several of these laws seek to require polluters to internalize the environmental costs of their discharges that were being passed on, or "externalized," to the environment. Most notable is the retrospective liability provided by the 1980 Superfund law, which incorporates an extremely broad approach to making polluters pay.[30] The Superfund law contains even more specific provisions aimed at enhancing enforcement. Building on principles that had developed through the common law of tort, Superfund provides for liability that is strict, joint and several. The statute also provides for recovery of triple damages if responsible parties

ENVIRONMENTAL LAW AT THE STATE LEVEL

Because of the size of the nation, the complexity of its environmental programs and the sheer numbers of facilities to be regulated, environmental programs in the United States rely to a considerable extent on shared authority and cooperative arrangements between the federal government and those of the 50 states to implement and enforce national environmental laws.

Under several federal statutes, including the Clean Air Act, the Clean Water Act, the Resource Conservation and Recovery Act, the Federal Insecticide, Fungicide, and Rodenticide Act, and the Safe Drinking Water Act, states may be delegated the authority to issue permits and take enforcement actions if their programs and standards are approved by the federal Environmental Protection Agency. States with such authority issue the vast majority of all permits granted pursuant to these laws, conduct a large percentage of all facility inspections, and initiate most enforcement actions against violators. The federal government's principal role in states with delegated programs is establishing national policy, developing national pollution standards, and monitoring the state programs to ensure that their actions are appropriate and consistent with national policies and standards.

Some states have reorganized to consolidate environmental programs under one agency. In the state of New York, the Department of Environmental Conservation combines conservation, wildlife management, and forest, marine, and mineral resource programs with responsibilities for water and air pollution control and solid and hazardous waste management. In California, the state's Environmental Protection Agency oversees and coordinates the activities of the Air Resources Board, the Water Resources Control board, and the Waste Management Board, while the separate Resources Agency, contains the Departments of Conservation, Fish and Game, and Parks and Recreation, among other units.

Enforcement of environmental laws in states with delegated programs is the responsibility of various state authorities. Environmental or health agencies frequently have the authority to issue administrative penalty orders for violations. States also use judicially enforced civil penalties in the enforcement programs. Civil penalty cases are prepared and filed by the offices of state attorneys general in most jurisdictions. Finally, states increasingly are using criminal sanctions to enforce federal environmental laws. In most states that pursue environmental crimes cases, the state attorney general plays a role in either prosecuting or investigating the criminal activity. In many jurisdictions, local district attorneys are also involved in criminal prosecution.

Several states have environmental laws that are more stringent than or different from federal laws. For example, many states have groundwater protection and wetlands statutes that go beyond the requirements of the federal Clean Water Act. Some states also have general statutory provisions designed to ensure that the environment is protected. One example is the Minnesota Environmental Rights Act, which allows any person in the state to sue any other person to prevent pollution, impairment or destruction of the environment.

A recent trend in the United States is the consideration of an expanded role for local government authorities in environmental protection. The number of facilities subject to environmental regulation has grown dramatically since 1985. The primary area of growth has been in the regulation of toxic substances frequently used or discharged by smaller facilities. The enforcement workload generated by these changes is enormous and, in many cases, beyond the resources available at the state level. A recent audit of Minnesota's environmental program estimated that dry-cleaning facilities generating hazardous waste would be inspected, given current state staffing levels, once in every 100 to 300 years. The rapid increase in workload has resulted in a new look at the role local governmental officials could and should play in issuing permits and enforcing environmental laws.

refuse to undertake cleanup after being ordered to do so. Superfund's enforcement power, its attention to the economics of pollution, and its consequent effect as a powerful deterrent to polluters helped to usher in a new and still-developing phase of environmental law.

CURRENT DEVELOPMENTS

New Strategies for Environmental Compliance

The combination of the environmental impact assessments for federal activities and resource-specific regulatory statutes has achieved significant results.[31] Nationwide, many forms of pollution have been reduced. Investment in pollution control has increased dramatically; it is estimated that by the year 2000, pollution control costs will constitute approximately 2.8 percent of the U.S. gross national product (GNP), assuming full implementation of current environmental regulations. (For further discussion of pollution control expenditures, see the section on Economic Development and the Environment in Chapter 4).

The United States has not allowed polluters to simply pay for the privilege of polluting; enforcement actions have sought to remove the profit from environmental violations, to impose additional penalties as a deterrent and to seek injunctions against illegal practices. In the past two years, court orders and judgments have forced several thousand-million dollars' worth of cleanups and installation of pollution control equipment, and have imposed tens of millions of dollars in civil penalties.

Violators of environmental laws are also learning that willful disobedience will be criminally prosecuted. Where disregard causes significant harm and there is clear evidence that the violator knew such harm was a likely result of its conduct, stiff criminal penalties—including substantial fines and actual jail time—can be imposed. During 1989 and 1990, the U.S. Justice Department obtained 170 guilty pleas and convictions under U.S. criminal environmental statutes, with more than 120 years of jail time imposed. Criminal penalties totaled more than $42 million during the two-year period.[32] As a result of increased penalties, most companies are concluding that they cannot afford to ignore or discount the environmental consequences of their actions.

As the United States enters the next phase in the evolution of environmental law, there is increased awareness that effective environmental protection and control involves more subtle and complex variables than were considered under earlier, centralized, command-and-control approaches. Building upon the strengths of existing legal structures and institutions, the United States is formulating a variety of strategies in the field of environmental law and regulation to deal with these effects. First is the development of more comprehensive multimedia approaches to environmental management. Some existing statutes provide a basis for such multimedia approaches. U.S. national forest management statutes have been amended to take into account the diversity of plant and animal communities.[33] Some of the more recent statutes protecting marine and coastal areas seek to integrate management of a particular area and all its resources.[34] And, using a combination of existing statutes in concert, the United States has begun to bring "multimedia" enforcement actions, prosecuting polluters simultaneously under air, water and hazardous waste statutes.

There is a growing realization that in many instances it is far cheaper to prevent pollution than it is to clean it up, particularly when many polluters first try to resist meeting their cleanup obligations by engaging in expensive litigation. In the Pollution Prevention Act of 1990, Congress stated a national policy that "pollution should be prevented or reduced at the source whenever

feasible," and that "disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner."[35] This statute also requires development of a national source reduction strategy, and calls on the states to promote the use of source reduction techniques by businesses, which some states are already doing.

The frequency, complexity and expense of environmental litigation has stimulated increased interest in the use of alternative mechanisms for resolving environmental disputes.[36] In some cases, pollution control can be achieved just as effectively, for less cost, if firms are allowed some flexibility and encouraged to innovate, so that the competitive free-market spirit is harnessed to environmental advantage. Market-oriented, economic-incentive-based approaches are increasingly being incorporated into law in the United States as means of achieving overall levels of pollution control that equal or exceed those found in technology-based command-and-control regulation.[37]

U.S. experience with economic incentives for environmental compliance is most extensive in the area of air pollution control. Under the Clean Air Act, EPA has created a market in the trading of allowable emissions increments. A single enterprise can shift emissions allowances among different sources within its plant, so long as it does not exceed its overall emissions limitations. A new source of emissions can start up in an area in which new emissions are otherwise prohibited if it obtains more-than-offsetting decreases in emissions from other sources in the area, resulting in substantial cost-savings (in the thousand-millions of dollars), with no increase in aggregate emissions levels. A similar program of tradable credits was used to phase out lead in gasoline, with similarly impressive cost reductions.[38]

An even more ambitious proposal has recently been enacted in the United States to control acid precipitation.[39] The Executive Branch proposed, and Congress in 1990 enacted as part of amendments to the Clean Air Act, a tradable emissions allowance program to control emissions of sulfur dioxide (SO_2), a key precursor of acid precipitation. The new legislation requires an overall reduction in the amount of SO_2 that U.S. power plants can emit. It allocates to power plants a limited allowable level of emissions. Utilities that can cost-effectively reduce their emissions below their allocated level can sell the resulting credits to power plants that find it more expensive to make the marginal reduction to allowable levels. It is estimated that this program will reduce SO_2 emissions with a cost savings of about $1 thousand-million per year as compared with reduction programs that do not employ trading.

INTERNATIONAL DIMENSIONS

Several challenges and opportunities remain as the last two decades of 20th century come to a close. One current problem that Congress and the executive branch are seeking to resolve is how to enforce federal environmental laws effectively against federal entities that pollute. Another is how to improve the ability of regulatory officials to make meaningful policy choices under conditions of scientific uncertainty. Significant questions remain about how best to weigh and integrate competing environmental and non-environmental concerns. U.S. officials are increasingly being called upon to make such determinations on environmental issues of national and international importance.

Since 1980 the United States has become a formal party to more than 40 international treaties, conventions, and other legal instruments in the areas of environmental protection and resource conservation. Building on these agreements, the United States will, in the 1990s and beyond, apply its experience with environmental law and institutions to four broad areas of

international concern. First is the negotiation and implementation of international agreements. International and transnational environmental problems require development of cooperative approaches negotiated by sovereign governments. Drawing upon lessons learned during the previous decades, the United States has proposed that the current negotiations toward an international framework convention on climate change should take a comprehensive approach that addresses all greenhouse gases, including their sources and sinks, in concert.[40] The United States has also noted that market-based incentive approaches, such as tradable allowances and emissions fees, are useful economic instruments that might be considered in the context of national and international approaches to climate change and to the development of other international environmental agreements.

A second set of international issues concerns the unilateral reach of domestic environmental legislation outside the territory of the United States. These issues pertain to U.S. government activities abroad, to activities abroad of corporations headquartered or doing business in the United States, to transboundary pollution questions, and to activities of non-U.S. entities abroad that affect the environment of the United States. With regard to the activities of U.S. agencies abroad, the United States is committed to analyzing the environmental impacts of its activities both inside and outside U.S. territory. Accordingly, U.S. agencies are required by presidential executive order to assess the environmental effects of major actions proposed outside the United States.[41]

In addition, U.S. development projects must be evaluated for their impact on the environment and natural resources of developing countries.[42] The United States is working with other governments to develop cooperative approaches to the assessment of extraterritorial environmental impacts of national actions. The United States recently signed a new convention on transboundary impact assessment and a new protocol on environmental protection of the Antarctic, which includes a provision for the environmental assessment of Antarctic activities.[43] Experience gained in implementing these legal instruments should be useful in addressing other questions of extraterritoriality.

A third concern is the export of materials that have been banned or severely restricted in the United States such as hazardous wastes and pesticides. The United States was one of the first countries to participate in international "prior informed consent" systems for export of pesticides. U.S. law also prohibits the export of hazardous wastes without the prior informed consent of the country of import.[44] Calls for a more complete ban on exports of such pesticides and wastes, and for increasing controls on imports of agricultural products containing residues of pesticides, are being considered at the domestic and international levels.

A fourth international environmental law concern that will demand greater attention in the 1990s and beyond is the mutual enforcement of environmental commitments. Countries will increasingly expect each other to enforce domestic legislation implementing international commitments. The United States has been a leader in this field, bringing criminal prosecutions, for example, against individuals and entities that import wildlife and wildlife products in violation of our domestic legislation implementing the CITES convention, or that traffic illegally in hazardous wastes. The United States was also the first nation to prosecute companies that imported chlorofluorocarbons (CFCs) in violation of U.S. rules implementing national obligations under the Montreal Protocol on Substances that Deplete the Ozone Layer.[45]

Increasingly, enforcement issues are being raised in the international as well as the domestic context. The United States and other nations that

invest a substantial amount of funds and effort in environmental compliance and enforcement will expect other countries to meet comparable standards. A number of international agreements use trade measures as a means of encouraging countries to join their environmental protection regimes; the trade measures seek to eliminate the short-term benefits that might otherwise accrue to countries that refuse to become parties to the agreements.[46] U.S. imposition of unilateral trade sanctions against countries that fail to meet U.S. environmental protection standards has recently been challenged in the General Agreement on Tariffs and Trade (GATT).[47] The United States is participating actively with the nations of the General Agreement on Tariffs and Trade (GATT) and other institutions to advance global understanding and resolution of the difficult questions that lie at the nexus of trade and environmental concerns. (For more information, see Chapter 4.)

Endnotes:

1. For the text of most major federal environmental statutes, see *Environmental Statutes 1991-92* (West Pub. Co.: 1991). For an outline summary of many major federal environmental regulations and policy documents, see *Environmental Law Reporter* and *Environmental Law Deskbook* (Washington, D.C.: Environmental Law Institute, 1989), 764 pages. For more comprehensive presentations of U.S. environmental statutes, case law, policies and regulations, see, *inter alia*, Rodgers, Anderson, et al. Schoenbaum and Rosenberg, Wilkinson, etc.
2. See Appendix A: Environmental Responsibilities of the Legislative Branch; Appendix B: Environmental Responsibilities of the Executive Branch; Appendix C: The U.S. Court System. More than 18 separate federal agencies administer more than 80 different environmental statutes. In many instances these agencies enforce environmental statutes through administrative procedures. The Department of Justice is responsible for conducting civil and criminal environmental litigation in the federal courts.
3. The U.S. Constitution, Article 1, Sec. 8, Clause 3.
4. For a discussion of laws pertaining to indigenous peoples, please see Chapter 3, "Indigenous Peoples."
5. See, e.g. *U.S. v. Riverside Bayview Homes,* 474 U.S. 121 (1985).
6. The Constitution requires that persons bringing suit must establish their legal standing to sue before the courts will hear their claims. Litigants have standing when they have suffered concrete injury caused by the challenged conduct and redressable by the relief they are requesting.
7. Under certain environmental statutes and the Equal Access to Justice Act, 28 U.S.C. §2412, private entities who prevail against the federal government in litigation may in limited circumstances recover their costs and attorneys' fees. The net result is that under the federal environmental statutory framework, private litigants' access to the courts has increased dramatically.
8. See *In re "Agent Orange" Product Liability Litigation*, 475 Fed. Supp. 928, 934 (E.D.N.Y. 1979). A number of countries are considering incorporating such a right into their national constitutions, and several have already done so. A distinction might be made between constitutions of countries that establish environmental rights, which number more than 12, and constitutions that create environmental obligations, which number approximately 50. While the U.S. Constitution does not create any explicit environmental rights, at least three states (Hawaii, Massachusetts and Pennsylvania) have enacted constitutions which refer to such environmental rights. For discussion see: E. Brown Weiss, *In Fairness to Future Generations* (1989).

9. For example, the demand for full restoration of environmental damage, enforced through federal suits for natural resource damages, is one mechanism by which the federal government seeks to quantify and protect the interests of present and future generations. Under the Clean Water Act, 33 U.S.C. §1321; the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 U.S.C. §§9601 *et seq.*; Title III of the Marine Protection, Research and Sanctuaries Act (MPRSA), 16 U.S.C. §1443; and the Oil Pollution Act of 1990, Public Law 101-380, §§1002, 1006, governmental trustees of natural resources may claim monetary damages from oil spillers, hazardous waste dumpers and persons who damage marine sanctuaries. The proper valuation of injury to natural resources is a developing area of the law. See U.S. Department of the Interior, "Natural Resource Damage Assessments," 56 Fed. Reg. 19752 (April 29, 1991); and see *Ohio v. Department of the Interior*, 880 F.2d 432, 461 (D.C. Cir. 1989).

10. See, for example, National Park Service Act of 1916, 16 U.S.C. §§1 and 2-3; Organic Administration Act of 1897, 16 U.S.C. §§473-82, 551 (forest management); Act of Jan. 24, 1905, ch. 37, 33 Stat. 614, and Act of June 29, 1906 ch. 3593, 34 Stat. 614 (wildlife ranges); Act of May 23, 1908, ch. 192, 35 Stat. 267 (national bison range); Migratory Bird Conservation Act of 1929, 16 U.S.C. §703 *et seq.* See also the table of laws relating to fish and wildlife protection in the Chapter 6 section on biodiversity. States enacted similar programs for resources within their borders that they considered deserving of protection. Particular disasters, often triggered by inappropriate exploitation of resources, sparked additional legislation at both federal and state levels. See, e.g., the Soil Conservation Act of 1935, 16 U.S.C. §590 a *et seq.*, enacted in response to the "Dust Bowl" conditions of soil erosion in the West during the early 1930s.

11. See Federal Insecticide, Fungicide and Rodenticide Act, 7 U.S.C. §§136 *et seq.* (1947).

12. See the Multiple-Use Sustained-Yield Act of 1960, 16 U.S.C. §§528-531; compare with Organic Administration Act of 1897, *supra*.

13. The Wilderness Act of 1964, 16 U.S.C. §§1131-1136. The act has been amended many times since, primarily to add additional tracts of federal land to the system; by 1990 the total area of all the tracts designated as wilderness by Congress was 38 million hectares.

14. See, for example, Act of June 30, 1948 (water pollution control); and see Act of July 14, 1955 (air). These federal statutes were enacted against a backdrop of state common law pertaining to tort liability, including the law of public and private nuisance. This common law of liability formed the basis for future federal enactments; today, it still fills some gaps in the state statutory framework.

15. See the National Environmental Policy Act (NEPA), 42 U.S.C §4344. For a more detailed discussion of NEPA see Chapter 8.

16. See the Administrative Procedure Act, 5 U.S.C. §§551 *et seq.*; the government in the Sunshine Act, 5 U.S.C. §§552(b) (public disclosure and open meeting requirements).

17. See, for example, the Administrative Procedure Act, 5 U.S.C. §§701 *et seq.*; the Endangered Species Act, 16 U.S.C. §1540(g); the Federal Water Pollution Control Act, 33 U.S.C. §1365; and the Solid Waste Disposal Act, 42 U.S.C. §§6972, 6976. Within the constitutional and prudential requirements for standing to sue, individuals and organizations were thus enabled to bring environmental cases on behalf of themselves and their membership.

18. National Environmental Policy Act (NEPA), 42 U.S.C. §§4321-4347. Under authority provided to the Council on Environmental Quality (CEQ) by Executive Order 11514 (March 5, 1970, as amended by E.O. 11991, May 24, 1977), CEQ has promulgated regulations concerning NEPA implementation.

19. Endangered Species Act, 16 U.S.C. §§1531-1544 (1972).

20. An historical antecedent to the types of environmental assessment obligations embodied in NEPA and ESA is the Fish and Wildlife Coordination Act, 16 U.S.C. §661 *et seq.* As a practical matter, many of the assessment and consultation obligations of this statute have been incorporated into the EIS process required by NEPA.

21. Endangered Species Act, 16 U.S.C. §§1531-1544 (1972). See the section on biodiversity for further discussion of this statute.

22. Emergency Planning and Community Right-to-Know Act, 42 U.S.C. §§11001-11050 (1988). Under the U.S. securities laws, publicly held firms are also required to disclose any and all environmental information that is financially material to investors and shareholders, including information pertaining to the economic effects of environmental compliance. (See 17 C.F.R. §229.101, and for certain information pertaining to environmental litigation in which the firm is involved, see 17 C.F.R. §§229.103 and 229.303). See also Van Cleve, "The Changing Intersection of Environmental Auditing, Environmental Law and Enforcement Policy," *Cardozo Law Review* (1991); and see P. Reed, "Environmental Audits and Confidentiality: Can What You Know Hurt You As Much As What You Don't Know?," 13 *Environmental Law Review* 10303 (December 1983).

23. The Freedom of Information Act (FOIA), 5 U.S.C. §552, provides generally for public access to government documents; however, consistent with the constitutional recognition afforded patents, agencies may withhold trade secrets and confidential business information. Similarly, laws providing for public access to information about pesticides and toxic chemicals require that confidential business information be protected. Other specific provisions of FOIA protect against disclosure of personnel, medical or national security information.

24. See 42 U.S.C. §7401 *et seq.*

25. See 33 U.S.C. §§1251 *et seq.*

26. See 42 U.S.C. §§6902 *et seq.* Provisions aimed at prevention, detection and correction of leaks from underground storage tanks, and establishing a demonstration medical-waste tracking program were added during the 1980s. See 42 U.S.C. §§6992.

27. See 42 U.S.C. §§2601 *et seq.*

28. See 15 U.S.C. §1531 *et seq.*

29. Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, 1980 and amendments), 42 U.S.C. §9601 *et seq.*

30. Notwithstanding the "polluter pays" principle, the federal government has in some areas provided substantial funding to help meet environmental goals. For example, the United States has spent over $10 thousand-million on water and sewage treatment facilities, a public works expenditure second only to construction of the best interstate highway system.

31. See U.S. Environmental Protection Agency, "Environmental Investments: The Cost of a Clean Environment," (1990) provides details on percentage reductions of specified pollutant emissions and investments in pollution control technology which provides. Also U.S. Environmental Protection Agency, "Meeting the Environmental Challenge: EPA's Review of Progress and New Directions in Environmental Protection," (EPA, 21K-2001, December 1990), and U.S. Department of Commerce, Bureau of the Census, *Statistical Abstract of the United States: 1990*, at Tables 347-362 (DOC 1990).

32. The United States can pursue both civil and criminal remedies. In litigation arising out of the *Exxon Valdez* oil spill, the federal district court in Alaska, on October 8, 1991, approved a criminal plea agreement and a civil consent decree resulting in a $1.125 thousand-million recovery. This is the largest and most comprehensive settlement in the history of U.S. environmental law, and resolves all

criminal and civil litigation between the federal and state governments, and the defendants relating to that spill. In addition, the United States and Alaska governments entered into agreements with Alaska Native groups and private plaintiffs to assist them in resolving their pending civil litigation for damages from the same spill.

33. See National Forest Management Act, 16 U.S.C. §1604 (g).

34. See Coastal Zone Management Act, 16 U.S.C. 1451 *et seq.*, and Title III of the Marine Protection, Research and Sanctuaries Act of 1972 (Marine Sanctuaries), 16 U.S.C. 1451 *et seq.*

35. Pollution Prevention Act of 1990, 42 U.S.C. §§13102-13109.

36. See Dinkins, "Shall We Fight or Shall We Finish: Environmental Dispute Resolution in a Litigious Society," *Environmental Law Review* vol.14 (1984): p. 10398. Newly enacted legislation encourages the use of alternative mechanisms in specified circumstances. See, e.g., the Administrative Dispute Resolution Act of 1990, Public Law 101-552; and see the Negotiated Rulemaking Act of 1990, Public Law 101-648.

37. See Stewart, "Controlling Environmental Risks Through Economic Incentives," 13 *Columbia Journal of Environmental Law* 153 (1988); Dudek, Stewart and Wiener, "Environmental Policy for Eastern Europe: Technology-Based Versus Marked-Based Approaches," Budapest Regional Environmental Center, March 27, 1991. For a report on what 29 organic chemical plants are doing voluntarily to reduce hazardous wastes, see Sarokin, Muir, Miller and Sperber, *Cutting Chemical Wastes,* (New York: Inform Inc. 1985).

38. See Hahn and Hester, "Marketable Permits: Lessons for Theory and Practice," *Ecology Law Quarterly* vol.16 (1989): p. 361.

39. See Clean Air Act of 1990, Title IV; Dudek, Stewart and Wiener, *supra*, at 14-15.

40. See "A Comprehensive Approach to Addressing Potential Climate Change" (U.S. Task Force on the Comprehensive Approach to Climate Change, February 1991). For a more detailed discussion of climate change, see Chapter 6.

41. See Executive Order 12114, "Environmental Effects Abroad of Major Federal Actions," January 4, 1979.

42. See Section 117 of the Foreign Assistance Act, 22 U.S.C. §2151p.

43. See the Economic Commission for Europe (ECE) Convention on Environmental Impact Assessment in a Transboundary Context, Espoo, Finland, February 27, 1991 (signed by the United States, February 27, 1991); the Protocol on Environmental Protection to the Antarctic Treaty, with Annexes, Madrid, Spain, October 4, 1991. (It was signed by the United States on October 4, 1991).

44. See the Resource Conservation and Recovery Act, 42 U.S.C. §3017 (hazardous wastes); and see "Pesticide Active Ingredients Intended for Export: Proposed Policy Statement," 55 Fed. Reg. 4956 (1990), implementing the prior informed consent components of the United Nations Environment Programme (UNEP) Amended London Guidelines for the Exchange of Information on Chemicals in International Trade.

45. As a means of implementing national obligations to reduce CFC consumption, the United States has established a tradeable CFC allowance system enforced by tough sanctions.

46. See Montreal Protocol, Basel Convention on the Control of Transboundary Movements of Hazardous Wastes, and CITES, all of which restrict international trade in controlled items.

47. See GATT Panel Report, D521/R, September 3, 1991, considering trade sanctions imposed under the Marine Mammal Protection Act, 16 U.S.C. §§1381 *et seq.* (banning importation of tuna from countries that have not reduced dolphin mortality to levels comparable to those required of U.S. vessels).

CHAPTER

6

NATURAL RESOURCES ENDOWMENT AND KEY ENVIRONMENTAL ISSUES

Overview

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A. Air Quality

■

B. Climate Change and Stratospheric Ozone Depletion

■

C. Freshwater and Wetlands

■

D. Oceans and Coastal Resources

■

E. Land and Mineral Resources

■

F. Plants, Animals and Biodiversity

■

G. Toxic Substances

■

H. Wastes

■

I. Biotechnology

OVERVIEW

The environmental resources of the United States are vast and varied. Its diverse climate, soils, water resources and topography provide habitats for many natural communities, and supply resources for many human uses of the nation's land and waters. With about 60 percent of the total land area in private ownership, the private sector has played a primary role in developing and managing those land, water, biological and mineral resources. The federal, state and local governments have also made important contributions to protecting environmental quality through regulation, economic incentives and education, as well as by directly managing most of the other 40 percent of the nation's land as forests, parks, wildlife preserves, resource development and rangeland, recreational areas and open space. Underlying these efforts have been private citizens demanding better environmental protection and management, seeking to be better informed about environmental risks, and influencing decisions in an open public process that is grounded in both tradition and law.

Environmental organizations and other public and private interest groups in the United States have frequently influenced the development, implementation and timing of state and federal programs. Groups active in environmental management issues include long-established national conservation organizations and younger public interest groups. Recent changes in the law, such as provisions in the Clean Air Act allowing citizen suits and the increased availability of emissions data, including the Toxics Release Inventory, have enabled interested organizations and individuals to obtain reliable detailed information about the sources and causes of pollution.

Today, more public pressure for environmental protection is being brought to bear on all sectors of U.S. society than ever before, with increasing emphasis on preventing pollution from entering the environment from any source. According to a recent public opinion poll, "Public concerns about environmental degradation...are extremely high today [and] have been rising strongly over the past few years. This dramatic shift in American's attitudes toward the environment...has encompassed virtually every group in American society—young and old, black and white, Easterner and Westerner."[1]

The several sections of this chapter describe many ways that government agencies and the private sector are responding to this growing public concern. More than ever before, efforts are being made first to understand the linkages between economic and environmental issues, and then to implement solutions that are both effective and affordable. The many changes underway in the management of the natural resources of the United States reflect an increasing understanding that prosperity enables more investment in environmental protection, and that stewardship is essential for the nation's and the world's long-term economic well-being.

Evolution of Responsibilities

As is indicated in Chapter 5, Environmental Law and Institutions, the United States began federal regulatory efforts to protect the environment near the end of the last century; it was not until the 1970s, however, that most of the existing federal environmental laws, agencies and regulatory programs were created. These new programs responded to rising public concern about environmental degradation and to inadequacies of controls that previously had been imposed solely at local and state levels. Environmental protection at the national level thus evolved from state and local regulatory efforts (with federal research and technical assistance) into strong federal regulatory programs implemented in partnership with the states.

The post-1970 federal regulatory efforts to curb pollution built on longstanding resource conservation and public health programs. The United

States established the U.S. Environmental Protection Agency (EPA) primarily to control pollution in order to better protect human health and the environment, while leaving related activities such as natural resource management (wildlife, minerals, parks, forests, agriculture, fisheries, etc.) with the Departments of the Interior, Agriculture and Commerce, and most aspects of public health protection with the Department of Health and Human Services and the Department of Labor. The result is that the federal government's responsibility for environmental protection and management is shared among several departments and agencies. The degree of shared responsibility is especially high in areas that support both regulatory and resource management activities, such as research and environmental data collection.

Responsibility for environmental protection also is shared among different levels of government in the United States. Each of the 50 U.S. states has its own way of handling environmental regulation and management activities. In general, the federal government is charged with functions such as research, national standard-setting, oversight, and technical and financial assistance, while state governments manage implementation by issuing permits and monitoring compliance with regulatory standards. As is also discussed in Chapter 5, the states generally have the discretion under federal environmental protection statutes to set standards more stringent than the national ones. Enforcement authorities are located in both state and federal governments; states take the lead in enforcement under certain programs where authority has been delegated by the federal government.

Land-use decisions usually are made by local governments. Local power to regulate land use is derived from a state's power to enact legislation to promote the health, safety and general welfare of its citizens. States vary in the degree to which they delegate these "powers" to local governments, but control over land use usually is exercised to a considerable extent at the local government (county or city) level. This control may take the form of authority to adopt comprehensive land use plans, to enact zoning ordinances and subdivision regulations, or to restrict shoreline, floodplain or wetland development.

The environmental laws and the programs that implement them are not uniformly structured, but vary in their mechanisms for standard-setting, monitoring and enforcement. Environmental permits, which allow government agencies to assess and regulate private-sector activities that can affect the environment, are a common (but by no means universal) feature of the programs. Also common are ambient environmental quality and/or emissions limitation standards. The major environmental protection programs established during the last several decades have depended heavily upon regulatory powers rather than on market or other incentives to reduce pollution. Programs that regulate toxic chemicals and pesticides allow a balancing of the risks and benefits of chemical use. Other programs limit economic considerations to the affordability of control technologies. In some cases the regulatory agencies have very little legal authority to consider any factors in regulatory decisions beyond risk to human health and the environment. Most statutory programs have emphasized control of pollutants after they have been generated (the Toxic Substances Control Act is one important exception), rather than prevention of their production and use.

Results

U.S. environmental protection programs have in general been successful in controlling discharges of pollutants to air and water from the sources they were empowered to control. These controls have produced large, measured improvements in air quality since the early 1970s, and notable improvements in the quality of waters that were polluted primarily by sewage and industrial

point-source discharges. Fish populations are returning to waters where pollution has been controlled, or the fish harvests limited, or where both have occurred. Some very harmful pesticides and other toxic chemicals have been removed from U.S. production and now are being found in lesser amounts as residues in the environment. Solid and hazardous wastes are being handled more safely. Uses of stratospheric ozone-depleting chemicals are being phased out. While the amount of agricultural and forest lands in production has not expanded, improvements in efficiency have led to marked increases in food and timber production. In the face of both population and economic growth over the past two decades, the U.S. environment is much healthier than it would have been without the environmental protection programs that were put in place during that period. As discussed in Chapter 4, this environmental protection costs U.S. citizens and corporations roughly $115 thousand-million annually (in private-and public-sector pollution control costs only), or about 2.1 percent of the U.S. gross national product (GNP).[2]

However, some very difficult and expensive work still remains to be done on the problems targeted during the 1970s and 1980s. One-third of the U.S. population resides in counties which did not meet air quality standards consistently during 1989. One-third of the nation's rivers that were evaluated in 1988 did not meet state water quality standards. Newly recognized problems also have emerged, some of them resulting from earlier control efforts. For example, removing pollutants from wastewater creates sludge, which can in turn pollute soil and groundwater if improperly managed or disposed. Deposition from air to water of nutrients, toxic substances and acidic agents appears to be contributing to serious water quality problems in some estuaries and lakes, including the Chesapeake Bay and the Great Lakes. Habitat alteration and destruction, including continuing losses of old-growth forests and wetlands and the potential for species extinctions, are growing concerns; increasingly, conservation efforts are focusing on the importance of preserving biological diversity. Recognizing the problem of increased pressure on wetlands, coastal waters and estuarine ecosystems, the United States has initiated important new programs aimed at preserving and enhancing them. Pesticide residues in food, exposures to toxic chemicals in workplaces, household wastes, toxic air pollutants, changes in the global atmosphere from byproducts of industrial production and individual human consumption—these and other concerns have led to rising interest in more sophisticated approaches to environmental protection.

New Directions

Although preserving past environmental gains will continue to require vigorous enforcement and enhancement of existing regulatory requirements, additional progress will also require different strategies, ones that have been put into practice in the United States only during the past few years. These approaches include:

Risk-based Planning and Management. Comparing and ranking different sources of risks to human health and environmental quality, and setting priorities based on the opportunities to reduce those risks, should lead to improvements in the efficiency of environmental protection efforts. This new approach seeks to direct resources toward the most serious problems. The United States is comparing and ranking sources of environmental and human health risks and has begun to use these analyses to influence government programs and budgeting at the federal, state and local levels.

Pollution Prevention. Preventing the generation of pollutants is likely to be more effective, and often less expensive, than imposing treatment and disposal controls that often only transfer pollution from air to water to land. The last

What Are the Highest Risk Problems?

A report by the Scientific Advisory Board for the U.S. Environmental Protection Agency in 1990, entitled *Reducing Risk: Setting Priorities and Strategies for Environmental Protection*, highlights several problems that continue to pose relatively high risks to human health and to the natural environment in the United States. It is important to note that the report compared ''residual risks''—risks from problems that remain after currently required controls have been applied. Some problems, such as hazardous waste, were ranked comparatively low, in part because many of the more serious risks had already been controlled as a result of existing regulations at the time of the survey. Among the problems rated as posing the highest risk to human health, based primarily on degree of direct public exposure to pollutants known to have significant health impacts, were:

- *Ambient Air Pollutants:* Stationary and mobile sources emit a range of different air pollutants to which large numbers of humans are exposed.
- *Worker Exposure to Chemicals in Industry and Agriculture:* Industrial and agricultural workers are exposed to many toxic substances in the workplace, exposures that can cause cancer and a wide range of non-cancer health effects.
- *Pollution Indoors:* Residential and office-building occupants may be exposed to radon and its decay products as well as to airborne combustion products and household products containing toxic agents.
- *Pollutants in Drinking Water:* Drinking water may contain agents such as lead, chloroform, and disease-causing microorganisms.

The report recommends that the U.S. government place increased emphasis on reducing ecological or environmental risks, recognizing that the health of natural systems is the foundation for economic health and the well-being of human society. The report identified the following problems as relatively high risks to the natural ecology and human welfare, based especially on their geographic scope and the amount of time it will take to reverse them (some are irreversible):

- *Habitat Alteration and Destruction:* Draining and degradation of wetlands, soil erosion and the deforestation of tropical and temperate rain forests are altering and destroying natural habitats worldwide.
- *Species Extinction and Overall Loss of Biological Diversity:* Many human activities are causing species extinction, depletion and the overall loss of biological diversity, including the genetic diversity of surviving species.
- *Stratospheric Ozone Depletion:* Releases of CFCs and other ozone-depleting gases are thinning the earth's stratospheric ozone layer, allowing more ultraviolet radiation to reach the Earth's surface, thus stressing many kinds of organisms.
- *Global Climate Change:* Emissions of carbon dioxide, methane and other greenhouse gases are altering the chemistry of the atmosphere, which may change the global climate.

few years have seen the introduction of a variety of innovative pollution-prevention programs by industry, states and localities, citizen groups and the federal government. For example, by October 1991 more than 400 U.S. companies had committed to voluntary reductions of 17 high-risk toxic chemical wastes by an average of 50 percent by 1995—more than 113 million kilos in total. Thousands more companies have been invited by the federal government to participate in this program to reduce nationwide releases of these chemicals by 33 percent in 1992, and by 50 percent in 1995. During the 1990s, pollution prevention is expected to become a major objective of many U.S. environmental protection programs.

Attention to the Large Number of Small Sources. Widely dispersed small pollution sources are more difficult to address by issuing permits, compared to large industrial facilities. Some of the most promising targets for further improving the environment lie outside the manufacturing and energy industries, in sectors such as agriculture. Surface runoff from farms is now recognized as the most extensive source of water pollution in the United States. The nation will continue to rely on participation and cooperation from homeowners, farmers, dry-cleaners, gas-station operators and automobile drivers—indeed, from all of the nation's citizens—to make additional progress in cleaning up air and water.

Market Incentives to Protect the Environment. Using market incentives to reduce pollution, which includes providing better information to help producers and consumers make informed choices, is emerging as an important way to gain environmental improvements. These tools supplement traditional regulatory programs and allow risk reduction to be maximized at lower cost. For example, the new Clean Air Act provides for a system of emissions-allowance trading by public utilities. Companies can "over-control" their emissions of pollutants that cause acid rain and recoup some of the costs by selling their emissions allowances to other companies that may choose, because of cost considerations, to control less and pay for the allowances. The system is expected to reduce overall national sulfur dioxide emissions by 40 percent in 10 years at an anticipated savings of about $800 million per year compared to traditional regulatory approaches.

Integrated Management of Risks. The U.S. experience has shown that protecting the environment through disjointed efforts aimed at separate problems will leave some very important problems unsolved. Many of the highest-risk problems, such as global climate change, species extinction and habitat alteration are the products of multiple causes acting through a variety of environmental pathways. The United States is making major efforts to marshall all the tools available to address priority problems in an integrated fashion. Ultimately, whole ecosystems may be the focus of most cleanup and protection efforts, rather than single environmental pathways or components within ecosystems, such as surface water, groundwater, air or wildlife alone.

Endnotes:

1. The Roper Organization, Inc., *The Environment: Public Attitudes and Individual Behavior*, 1990.
2. U.S. Environmental Protection Agency, *Environmental Investments: The Cost of a Clean Environment* (Washington, D.C.: November 1990).

—A—
Air Quality

Air Quality

The United States has made tremendous strides in reducing air pollution. Taken as a whole, data show a downward national trend in average ambient concentrations of the most prevalent air pollutants. In the 1980s, annual average concentrations of particulates fell by over 20 percent; sulfur oxide concentrations by over 35 percent; carbon monoxide concentrations by about 32 percent; and lead concentrations by 88 percent.[1] Air quality in the United States varies widely because of many factors, including climate, weather, topography and urbanization. Attempts to control air pollution have been influenced by the same factors, as well as by technical capability, economic strength and public attitudes. The first air pollution laws in the United States were passed by cities in the 1880s to control smoke emissions from factories and residences. By the 1950s, newer sources of emissions, such as power plants and automobiles, fueled public pressure to enact federal air pollution legislation; the Clean Air Act was passed by Congress in 1963. Major amendments to the act, passed in 1970 and 1977, established the overall philosophy and conceptual framework of the U.S. air pollution control program until passage of the Clean Air Act Amendments of 1990.[2]

The Clean Air Act, as amended, authorizes the federal government to set National Ambient Air Quality Standards (NAAQS) to protect public health and welfare. Ambient standards are allowable levels of pollutants in the outside air. Currently, primary standards, and in some cases secondary ones, are set for six "criteria" pollutants—sulfur dioxide, nitrogen dioxide, carbon monoxide, particulates, ozone and lead.[3] Primary standards are designed to protect public health, while secondary standards protect public welfare and include the effects of air pollution on vegetation, materials and visibility. (See Exhibit 6a.1.)

The federal government also sets emission limits for most major new stationary sources of air pollutants, for motor vehicles and fuels, and for large sources of hazardous air pollutants. Emission limits are amounts allowed to be released from sources. The act gives the states the basic responsibility for developing and enforcing state implementation plans to ensure compliance with the NAAQS through emission controls and a variety of other means. The states also monitor and control emissions of the federally regulated hazardous air pollutants; some states regulate many additional air toxics.

Annual direct expenditures to control air pollution (both public and private, including costs for controlling radiation) have increased steadily since 1970. Total annual costs increased from almost $8 thousand-million in 1972 to an estimated $31 thousand-million in 1990 (in 1986 dollars).[4] Direct expenditures to implement the new Clean Air Act requirements will increase to approximately $25 thousand-million a year when the act is fully implemented in 2005. However, the act is also expected to bring significant benefits measured in terms of human health and ecological protection, protection of natural resources and economic goods, and new business opportunities throughout the U.S. economy.

NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Primary Standards	Averaging Time	Secondary Standards
Carbon Monoxide	9 ppm (10 mg/m^3) 35 ppm (40 mg/m^3)	8-hour[a] 1-hour[a]	None
Lead	1.5 ug/m^3	Quarterly average	Same as primary
Nitrogen Dioxide	0.053 ppm (100 ug/m^3)	Annual (Arithmetic mean)	Same as primary
Particulate Matter (PM-10)	50 ug/m^3 150 ug/m^3	Annual (Arithmetic mean)[b] 24-hour	Same as primary
Ozone	0.12 ppm (235 ug/m^3)	1-hour[d]	Same as primary
Sulfur Dioxide	0.03 ppm (80 ug/m^3) 0.14 ppm (365 ug/m^3)	Annual (Arithmetic mean) 24-hour[a] 3-hour[a]	--- --- 0.5 ppm (1300 Ug/m^3)

[a] Not to be exceeded more than once per year.
[b] The standard is attained when the expected annual arithmetic mean concentration is less than or equal to 50 Ug/m^3.
[c] The standard is attained when the expected number of days per calendar year with a 24-hour average concentration above 150 Ug/m^3 is equal to or less than 1.
[d] The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is equal to or less than 1.

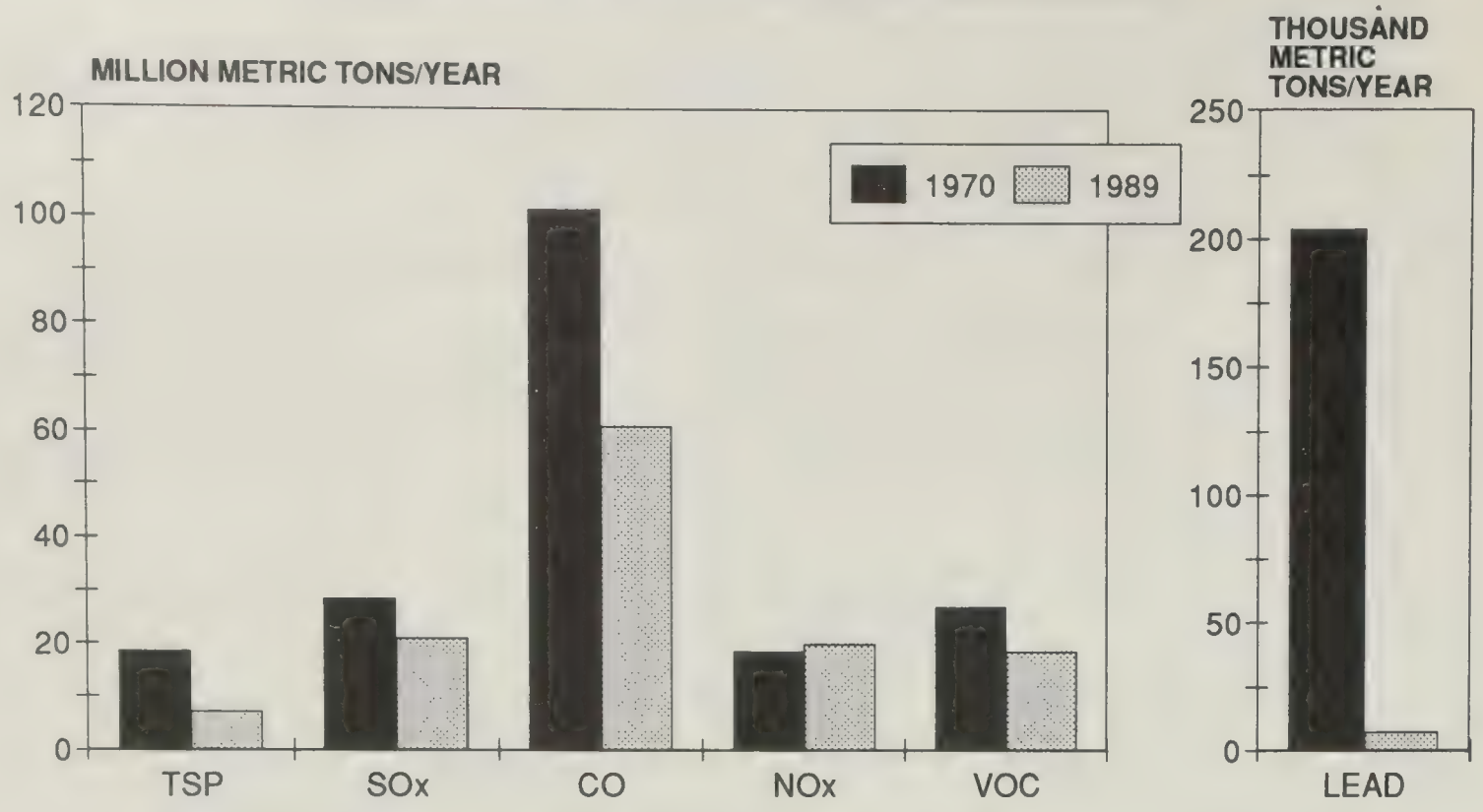
Exhibit 6a.1

Air Quality Trends

During the past two decades, the combined federal-state regulatory program established under the Clean Air Act has brought notable improvements in U.S. air quality. Emissions of all regulated pollutants except nitrogen dioxide have decreased. (See Exhibit 6a.2.) Nitrogen dioxide levels have remained essentially constant in recent years; only one city (Los Angeles) is in violation of the standard. Most areas of the United States meet the national air quality standards for sulfur dioxide and lead. However, 70 areas in the United States are in violation of the standard for particulate matter, 96 areas are in violation of the ozone standard and 41 areas do not meet the standard for carbon monoxide. Approximately 84 million people in the United States reside in counties that failed to meet at least one air quality standard as measured at one or more times during 1989.[5] (See Exhibit 6a.3.)

In addition, emissions of hazardous air pollutants remain a significant concern. More than 1.08 thousand-million kilos were released by industrial sources in 1989, and relatively few had been regulated during the 1980s. There is relatively little information on exposure and risk assessment for most toxic air pollutants at ambient concentrations. Nevertheless, the new Clean Air Act includes provisions that would reduce these emissions substantially.

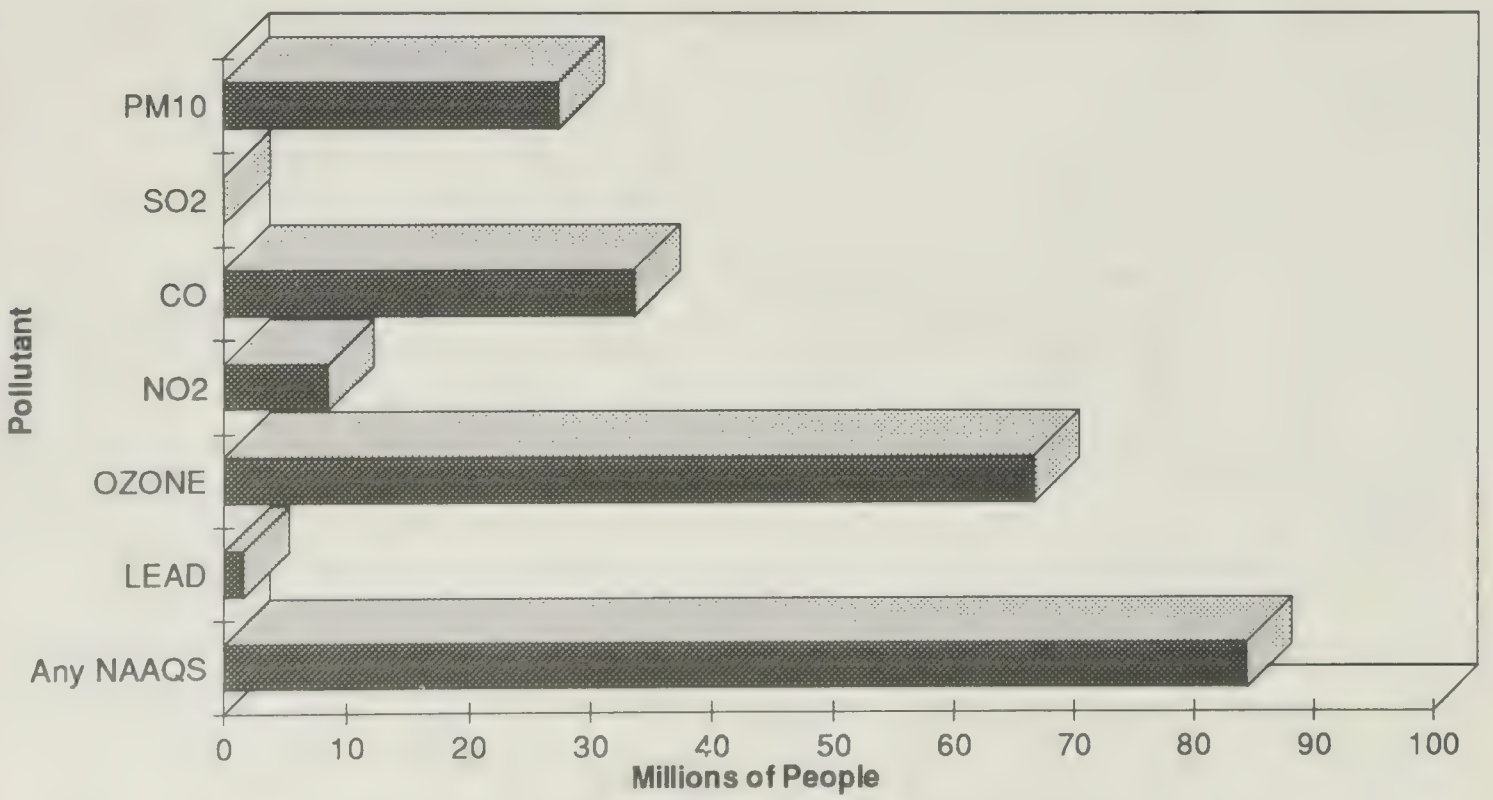
Comparison of 1970 and 1989 Emissions



Source: U.S. EPA, *National Air Quality Emissions & Trends Report, 1989,* February 1991.

Exhibit 6a.2

People in Counties That Did Not Meet the Primary National Ambient Air Quality Standards in 1989



Source: U.S. EPA, *National Air Quality Emission & Trends Report, 1989,* February 1991.

Exhibit 6a.3

As a whole, the Clean Air Act Amendments of 1990 are intended to improve significantly the ability of federal, state and local governments to attain ambient air quality standards, reduce toxic air pollutants and address the problem of acid deposition. To achieve these objectives through the most economic and efficient means, the act makes use of market-based approaches to supplement traditional regulatory authorities. The act also mandates the introduction of cleaner vehicles and fuels, and requires enhanced controls for all major sources of hazardous air pollutants.[6] Some of the principal elements of the 1990 amendments and their implications follow.

Criteria Pollutants Trends

- *Sulfur Dioxide.* Ambient concentrations of sulfur dioxide in the United States decreased 24 percent between 1980 and 1989. SOx emissions decreased 26 percent between 1970 and 1989.[7] Emissions from electric utilities, which account for two-thirds of national SO_x emissions, decreased about 11 percent during that same 20-year period.

- *Nitrogen Dioxide.* Average ambient levels of nitrogen dioxide declined only about five percent between 1980 and 1989. NOx emissions increased substantially during this century as a result of increased fuel consumption; a 16-percent increase was recorded from 1970 to 1978, after which emissions declined, resulting in an overall eight percent increase from 1970 to 1989. The primary sources of NOx emissions in the United States are motor vehicles and electric power plants.[8]

- *Ozone.* Ozone is formed by complex chemical reactions between volatile organic compounds (VOCs) and NOx in the presence of sunlight. Ambient ozone levels declined 14 percent between 1980 and 1989, although high ozone concentrations were found in both 1983 and 1988, attributable in part to hot, dry, stagnant atmospheric conditions at those times, which were conducive to ozone formation. Ozone health standards were not being met in 96 urban and other areas from 1987 to 1989. Emissions of VOCs have decreased since 1970, primarily as a result of controls on motor vehicle emissions, while nitrogen oxides increased during that period.

- *Carbon Monoxide.* There has been a general long-term improvement in ambient levels of carbon monoxide. Emissions declined 40 percent between 1970 and 1989, due mostly to controls on highway vehicles. Average ambient concentrations decreased 25 percent between 1980 and 1989.

- *Particulate Matter.* Estimated total particulate emissions have decreased by about 61 percent since 1970, primarily as a result of controls on power plants and industrial processes. Since 1987, EPA has been using a standard for PM-10 rather than for total suspended particulates (TSP). PM-10 refers to particles with aerodynamic diameters smaller than 10 micrometers, which are likely to be responsible for adverse human health effects because of their ability to reach the lower regions of the respiratory tract. Monitoring data indicate a three-percent decline in PM-10 emissions and ambient levels between 1988 and 1989.

- *Lead.* There has been a dramatic improvement in ambient lead concentrations in the United States in recent years, with nearly all areas of the country now in attainment with the NAAQS. Average ambient lead concentrations dropped 87 percent from 1980 to 1989. Emissions decreased 96 percent between 1970 and 1989. A 99-percent reduction in the use of lead in gasoline is mostly responsible for this improvement.

Other Air Quality Trends

- *Acidic Deposition.*[9] Sulfur dioxide and nitrogen oxides contribute to acid precipitation. Since the early 1970s, emissions of these acid rain "precursors" resulting from human activities have either decreased, or in the case of nitrogen oxides, remained essentially constant. In the Northeast, sulfur dioxide emissions and surface water sulfate concentrations both decreased during the past 20 years. In the Southeast, sulfur emissions increased and surface water sulfate concentrations also increased. The small number of lakes whose acidity is attributed to atmospheric deposition are found mostly in the Adirondack Mountains of northern New York, and in Florida. While acid deposition is responsible for about half of the acidic streams along the east coast and in the Appalachian Mountain areas, the other main causes of acidic surface waters are acid mine drainage and plant decay.[10]

- *Air Toxics.* There is no comprehensive assessment of toxic chemicals in the air or of their potential health effects. In 1989, more than 1 thousand-million kilos of toxic chemicals were reported released to the air by manufacturing facilities in the United States.[11] At least half of the air toxic emissions in the United States are believed to come from mobile sources (motor vehicles and fuels).[12]

- *Indoor Air Quality.* A growing body of scientific evidence indicates that air within homes and other buildings in the United States can have higher levels of air pollutants and greater health impacts than outdoor air. These pollutants include tobacco smoke, radon, volatile organic compounds, biological contaminants, combustion gases, respirable particulates, lead, formaldehyde and asbestos.[13] By some estimates, radon, a naturally occurring gas, is second only to smoking as a cause of lung cancer in the United States, especially for smokers.[14]

Implementation of the Clean Air Act

Some important aspects of Clean Air Act implementation are discussed below. The 1990 Amendments add important new provisions to the Clean Air Act and make major changes to some existing provisions.

Federal and State Responsibilities

Consistent with the U.S. approach to implementing environmental programs, the federal and state governments have distinct, yet complementary, roles and responsibilities. Under the Clean Air Act, the federal government is responsible for setting national standards and regulations, providing technical expertise and financial support to the states, and enforcing mobile source standards. The federal government is also responsible for approval of state programs, program oversight, and for promulgation and enforcement of controls where states fail to do so.

The states have primary responsibility for developing, implementing and enforcing air pollution control programs in response to federal standards, regulations and guidelines. Inherent differences between geographic areas of the country require state and local agencies to make decisions and set priorities to maximize popular, financial and political support for air control programs that are becoming increasingly expensive and difficult to implement. National standards, set by the federal government, provide a baseline intended to ensure that state and local programs will achieve minimum nationally acceptable levels of environmental protection. States are able however, to include additional requirements at their discretion to respond to regional and local needs and values.

Market-Based Approaches

The 1990 amendments to the act make extensive use of market-based approaches to reduce air pollution. Examples include the cornerstone of the acid rain control program, which is a market-based allowance trading system that will provide power plants with economic incentives and flexibility to reduce emissions. Another example is the new oxygenated motor vehicle fuels program, required in all areas that do not meet the carbon monoxide standard; the averaging and trading of oxygen credits is allowed within each area. A reformulated gasoline program is also required in the nine worst ozone areas, and averaging and trading of oxygen, benzene and aromatics is permitted within areas. Prior to the 1990 amendments, the trading and banking of credits played an important role in the phaseout of lead in gasoline, and helped prevent disruptions within the petroleum refining industry.

Environmental Research and Technology

Research and technology are essential to the effective control of air pollution. Extensive national resources are devoted to identifying pollutants, determining health and ecological effects of pollutants, developing monitoring and modeling technology, and developing effective control devices and other technologies for the mitigation of air pollution. Many federal agencies, universities, industries, private non-profit institutions and consulting firms are engaged in research in these areas. Cooperative research and information exchange programs also have been carried out with several other countries. The resulting body of knowledge and expertise is essential to the development, implementation, and enforcement of effective control strategies and regulations.

Several potential research topics that could receive increased emphasis as a result of the 1990 amendments include:

- Epidemiology and related studies of the chronic effects of ozone, and the health effects of acid aerosols and other particulate matter;
- The ecological effects of air pollution, particularly ozone, nitrogen and air toxics;
- Regional and local scale atmospheric models, emissions data and monitoring to track progress of Clean Air Act programs;
- The effects of alternative motor vehicle fuels and reformulated gasolines.

Enforcement

In 1989, record numbers of environmental violations were reported in the United States. The EPA air program alone took some 430 enforcement actions in 1989, and federally approved state programs reported another 1,200 actions.[15] Despite the large number of enforcement actions taken by the federal government, most environmental enforcement is conducted by the states. Facility inspections are the primary method for monitoring compliance. Surveillance acts as a deterrent, encouraging compliance with regulations by making those not in compliance susceptible to enforcement actions. The overall compliance monitoring program also allows the federal government to evaluate the effectiveness of state programs.

The 1990 amendments to the Clean Air Act strengthened criminal sanctions by increasing fines and jail terms for knowing violations. It also created new administrative authorities, allowing the federal government to issue compliance orders of up to one year's duration and to issue penalty orders of up to $200,000 on its own authority. Previously, the federal government's stationary-source enforcement power consisted almost exclusively of civil judicial actions filed in federal district courts.

The 1990 amendments also gave the federal government the authority to issue field citations, reviewable at an informal hearing, in amounts of up to $5,000 per day for a violation. Field citations are essentially "traffic tickets" which can be issued on the spot by a federal inspector in response to minor violations.

Issues in Air Quality

The major air quality issues in the United States at the present time are (1) health risks and welfare effects from remaining pollutants in the ambient air (mostly in metropolitan areas), especially ozone and toxic chemicals, (2) ecosystem and public welfare damages from regional air pollution, including ozone, acid deposition and visibility, (3) transboundary (international) air pollution, and (4) radon and other indoor air pollutants.

Ambient Air Quality

The Clean Air Act of 1990 prescribes some new requirements and approaches for solving our most serious remaining ambient air quality problems—in particular, the control of tropospheric ozone, carbon monoxide, particulate matter and air toxics.

Ozone, Carbon Monoxide, Particulates. The United States is broadening the scope of ozone, carbon monoxide and PM-10 regulation to cover small sources such as VOC emissions from motor vehicle fuels and commercial and consumer products, such as solvents and paint strippers, and PM-10 emissions from woodstoves and sources of fugitive dust. Future motor vehicles will be designed to emit fewer pollutants from the tailpipe as well as less evaporated gasoline vapors, and in some areas, motor fuels will be reformulated to be less polluting. Pursuant to changes in state implementation plans, vapor recovery devices are to be installed on gasoline pumps in some cities and improvements in vehicle emission inspection programs will also be required.

A majority of U.S. cities are expected to comply with the national ozone and carbon monoxide standards by the year 2000. Additional controls will be required in areas that do not meet prescribed timetables for attainment of standards. However, considerable scientific uncertainty remains, particularly on such questions as the role of biogenic emissions and NOx in the formation of ozone. Further research may lead to revised control strategies.

Toxic Air Pollutants. The Clean Air Act also establishes a program to reduce industrial emissions of air toxics by over 75 percent within the next 10 years. The act includes a list of 189 chemicals that are typically carcinogens, mutagens or reproductive toxins, and are emitted by certain specific industries. Sources emitting these chemicals will be required to install Maximum Achievable Control Technology (MACT) and, if necessary, to reduce emissions even further if a significant residual risk remains after installation of MACT. Controls on motor vehicles and fuels will also reduce toxic emissions. In addition, the federal government will set emission standards for "area sources," e.g. multiple small sources such as dry cleaners and gas stations. Provisions address air toxics emissions from coke ovens, municipal waste incinerators and certain high-risk facilities. The Clean Air Act also includes objectives for toxic air pollution control in the Great Lakes region.

Regional Environmental and Welfare Concerns

Regional Ozone. Data from non-urban areas indicate that elevated ozone concentrations occur throughout the eastern United States particularly the northeast in the summertime. Monitors in national parks downwind of major urban centers such as Los Angeles, California, also show violations of state and federal ozone air quality standards. Monitoring at Sequoia National Park showed that California ozone standards were exceeded 10 to 35 percent of the time, depending on the site.[16]

In addition to known health risks from elevated ozone levels in populated regions, damage to natural systems and agriculture from ozone appears to be a growing problem. The National Park Service found visible ozone injury to vegetation in most of the approximately 50 parks surveyed. Various species of pine (Jeffrey, Ponderosa, Eastern White) have shown needle or other tissue damage. Agricultural crop damage from regional ozone transport is estimated at $2 thousand-million per year.[17] One of the major ozone precursors in rural areas, nitrogen oxides, may also cause ecological damage through acidification, and may contribute to eutrophication of estuaries as an algae-producing nutrient.[18]

The 1990 Clean Air Act Amendments address regional ozone transport in non-urban areas not only through the national control strategies noted above, but also through reductions of nitrogen oxide emissions via the motor vehicle control program, the acid rain requirements for existing utilities, a requirement to strengthen the nitrogen oxide standards for new utilities, and most directly, by establishing ozone transport commissions, consisting of groups of states and the federal government working cooperatively to address regional ozone problems.

Acidic Deposition. U.S. policy during the 1980s involved a combination of support for continuing research on causes and effects of regional acidic deposition and a technology-development program to provide more cost-effective ways of reducing emissions. Over $500 million was spent by the National Acid Precipitation Assessment Program (NAPAP) on a 10-year federal study of the causes and effects of acidic deposition. NAPAP also compared and contrasted the costs and environmental benefits associated with various control options. In addition, the United States embarked on a $5 thousand-million (half publicly, half privately funded), five-year Clean Coal Technology program aimed at the commercial deployment of technologies that would allow the continued use of high-sulfur coal as an energy source, while simultaneously reducing pollution.

NAPAP documented the importance of acid deposition as a cause of some surface water acidification. The NAPAP research found that four percent of the lakes and eight percent of the streams surveyed under the National Surface Water Survey are chronically acidic, and 20 percent of the lakes and streams in the country have low capacity to neutralize acids and, therefore could undergo episodic acidification. Thus, greater than 90 percent of U.S. surface waters are not acidic. In addition, NAPAP studies determined that precursors of acid deposition are causes of more than 50 percent of the visibility impairment in the Eastern United States and 15 to 30 percent of the impairment in the West. Acid deposition itself is a cause of material damage and a contributor to the decline of some high-elevation spruce fir forests in the East. NAPAP research also raised concerns about the effects of acid aerosols on public health and acidic deposition on forest soils.

The 1990 Clean Air Act Amendments ended a decade-long policy debate over acid deposition in the United States by mandating a 10-million-ton reduction in annual emissions of sulfur dioxide, which represents a 40-percent decrease from 1980 levels. In addition, the 1990 amendments set a goal of a two-million-ton reduction in annual emissions of nitrogen oxides,

which is to be achieved through a combination of stationary- and mobile-source controls. The emission reductions are to take place in two phases, one beginning in 1995, and the other in the year 2000. There are some extensions available beyond the year 2000 for utility plants that choose to deploy new technologies. The 1990 amendments also call for a permanent national cap on emissions from the electric utility sector of 8.95 million tons of sulfur dioxide per year; this cap is intended to safeguard the environmental benefits of acid rain control, ensuring that they will not be eroded by increased emissions due to growth in energy consumption.

The act gives companies considerable flexibility in choosing how to achieve emission reductions, as contrasted to previous command-and-control approaches that mandated the use of certain types of technology (e.g., flue gas desulfurization units, known as "scrubbers"). An innovative market-based system of allowances and allowance trading is expected to achieve significant cost reductions (approximately 20 percent) compared to the mandated use of specific technologies. The expected cost of acid rain control in the United States will be about $1 thousand-million per year during Phase I (1995 to 1999), and $4 thousand-million per year when Phase II is fully implemented (post-2005).

The benefits of reduced acidic deposition are expected to include: gradual recovery of lakes already acidic, reduced acidification of sensitive lakes and streams, improved visibility, improved forest health, reduced damage to materials and reduced risk to public health (through reductions in SO_2, particulate matter and acid aerosols). The National Acid Precipitation Assessment Program was continued under the amendments to report, among other things, on the results of environmental monitoring programs and economic studies related to acid rain control.

Visibility. The ability to see distant objects has both aesthetic and practical value. Reductions in visibility by haze or smog can result from plumes generated by a single stationary source or group of sources such as refineries, smelters and coal-burning electric power plants, from buildup of vehicle emissions around urban areas, and from long-range transport of haze-generating pollutants from many sources across hundreds of kilometers. Long-term trends in visibility have shown increased impairment mostly occurring during the summer season across the eastern United States. In the eastern and southwestern United States, regional visibility degradation is caused primarily by sulfate particles formed from the release of sulfur dioxide. In the northwestern United States, carbon particles play an important role in degradation. In the west, regional impairment is usually less than in the east, due to lower sulfur dioxide emissions. The relatively pristine air quality conditions in most western rural areas make visibility impairment a matter of special concern, particularly at large national parks and in wilderness areas where scenic vistas attract many visitors.

Since 1980 the federal government's regulatory program for air pollution has focused on visibility impairment in national parks and wilderness areas. However, protection of regional visibility was only addressed indirectly, through controlling pollutants to meet ambient standards. The act as amended in 1990 will address regional haze directly in the east through the acid rain program, which should substantially reduce sulfur dioxide emissions, resulting in lower sulfate levels across the region. To address regional haze in the west, the act has strengthened work begun on the protection of visibility in national park and wilderness areas by establishing Visibility Transport Regions and Commissions. The federal government recently concluded a voluntary regulatory negotiation with

representatives of a utility company and several environmental groups that should significantly improve wintertime visibility in Grand Canyon National Park at a lower cost than was originally estimated.

Transboundary Transport of Air Pollutants

Recognition that the transboundary flow of air pollutants is a growing international problem has led the United States to join with other countries in both multilateral and bilateral agreements. The United States is a party to the Convention on the Long-Range Transport of Air Pollutants under the United Nations Economic Commission for Europe. That convention has a protocol on NOx. A protocol on VOCs is expected soon. The second phases of both the SO_2 and NOx protocols are currently under negotiation, and the convention will probably address toxic metals and persistent organic substances in the near future.

In the bilateral context, The U.S.-Canada Air Quality Agreement, signed in March 1991 by President George Bush and Prime Minister Brian Mulroney, provides the two countries with a flexible framework for dealing with air pollution issues. The agreement commits both countries to specific targets and timetables for reducing emissions of acid deposition precursors, and provides a formal mechanism to cooperate on a variety of issues, including environmental monitoring.

In November 1990, President Carlos Salinas de Gortari of Mexico and President Bush issued a joint communiqué calling for a comprehensive plan to reinforce border cooperation on environmental issues. The draft Integrated Environmental Plan for the Mexico-U.S. Border Area covers all media, including air. The initial objective is to prevent air pollution that exceeds ambient standards by controlling stationary and mobile sources. Air pollution was cited as a top-priority problem in the "sister cities," including Tijuana/San Diego, Mexicali/Imperial County and Ciudad Juarez/El Paso.

Radon and Other Indoor Air Pollutants

Congress has given the EPA authority to address indoor air pollution through the Indoor Radon Abatement Act and other statutes. In 1989, the EPA submitted a report to Congress on indoor air quality which concluded that "indoor air pollution represents a major portion of the public's exposure to air pollution and may pose serious acute and chronic health risks."[19] Although the existence of indoor air pollution has been well-documented, its extent in the United States remains unquantified, due in large part to the very limited scientific understanding of key exposure and risk-assessment issues. Limited efforts have been made to develop and communicate practical solutions to particular indoor air quality problems to building owners and managers, state and local governments, and the public.

Radon, however, is an exception. The United States has several research and operational programs to help states, local governments, the private sector and the public identify radon problems and take appropriate measures to prevent or correct them. In the 1990s, these programs will emphasize promoting public awareness, further developing state and private-sector capacity to address radon problems, and improving techniques for radon testing, mitigation and prevention.

For indoor air pollutants, the federal government has developed information and documents on how to reduce or prevent some of them, such as radon and asbestos, especially in home construction and rehabilitation.[20] The government also is conducting research into risks from individual pollutants and mixtures of pollutants. Strategies to address indoor air pollution are being explored, including regulatory and non-regulatory approaches such as public education, technical assistance, training and international cooperation.

CASE STUDY

REDUCING HAZE IN THE GRAND CANYON

Grand Canyon National Park, Arizona

The scenic vistas presented by the Grand Canyon on the Colorado River have awed and inspired visitors for generations. Grand Canyon National Park was established by Congress to protect this place of natural beauty and to assure permanent public access and enjoyment. At the visitor center on the south rim, one can see the canyon's north rim 10 miles away, and gaze at other geologic features visible at greater distances—on a clear day. For several years visitors to the park have found their view impaired by haze, sometimes to the extent that the opposite rim is not even visible. Photographs and other measurements taken by the National Park Service have documented these haze episodes, but identifying and controlling the source or sources of the haze, primarily sulfate particles formed from sulfur dioxide, has been difficult. Potential sources included coal-fired electric power plants in the region, copper smelters in southern Arizona and Mexico, and regional haze transported east by winds from the Los Angeles basin.

In 1980 the EPA issued regulations designed to protect visibility in specified national parks and wilderness areas, including the Grand Canyon. The regulations required control measures to be taken by individual sources shown to be contributing to the degradation of visibility. One of the largest coal-burning electric power plants in the United States is located within a few kilometers of the Grand Canyon; the plant burns up to 200 tons of low-sulfur coal per hour, and has no emission controls on the discharges from its stacks.

In 1987 the utility operators cooperated with the National Park Service and others in a winter study of emissions from the plant, which involved the injection of a tracer substance into the stacks of the plant and analysis of air samples taken from various locations in the region, including one site on the south rim of the Grand Canyon. The study found emissions from the power plant in the samples taken at the park. Several environmental organizations then sought to compel the state of Arizona and the EPA to require the utility owners to install controls to limit SO_2 emissions by 90 percent, on the grounds that the plant was contributing to visibility impairment in the park. The utility owners argued that other sources were far more significant contributors, and that the cost of the control technology to be required would be excessive.

Early in 1991 the EPA proposed regulations that would have required a 70-percent reduction in SO_2 emissions. This was the first time the EPA had directly required an existing source to reduce its emissions to improve visibility. In response to the proposed regulations, the utility owners and operators, several environmental organizations, and the EPA negotiated an agreement that should not only achieve lower emissions than EPA's initial proposal, but should do so at a lower capital cost. EPA's first proposal would have required control technology to achieve a 70-percent annual reduction in SO_2 emissions at an estimated capital cost of $510 million; the negotiated agreement calls for a 90 percent annual SO_2 reduction at an estimated capital cost of $430 million.

Under the acid rain provisions of the 1990 Clean Air Act Amendments, sources of sulfur dioxide that reduce emissions below required levels receive credits in the form of marketable allowances that can be sold or traded. These provisions should allow the owners of the Arizona utility to recover a portion of their increased operating costs as well.

Endnotes:

1. U.S. Environmental Protection Agency, *Environmental Investments* (December 1990).
2. Public Law 101-549.
3. Regulation of ozone under the Clean Air Act is restricted to excess ozone in the troposphere, or lower atmosphere, where its role as an oxidant can be harmful to agricultural crops, trees and other vegetation, and to animal and human health. Ozone in the upper atmosphere, or stratosphere, performs the beneficial function of reducing harmful ultraviolet solar radiation. Efforts to prevent continued depletion of stratospheric ozone are discussed in this chapter's section on global climate change.

4. U.S. Environmental Protection Agency, *Environmental Investments* (December 1990).

5. Because most people spend the majority of their time indoors, the human populations in the "non-attainment" areas (countries not meeting the NAAQS for one or more pollutants) are exposed to pollution levels in excess of the standards for relatively short periods of time. For example, while more than 66 million people live in countries that exceed the ozone NAAQS, only 20 million are estimated to be exposed during moderate exercise, for an average of nine hours annually. (Office of Technology Assessment, 1989).

6. U.S. Environmental Protection Agency, *National Air Quality and Emissions Trends Report, 1989*, EPA-450/4-91-003 (February 1991).

7. SOx and NOx are terms commonly used to represent gaseous mixtures of, respectively, sulfur oxides or nitrogen oxides, as distinguished from SO_2, meaning sulfur dioxide alone, or NO_2, for nitrogen dioxide alone.

8. See above note.

9. Acid rain is the popular term for acidic deposition, in which chemical species fall to the Earth in either wet (rain, snow, fog) or dry (gases, particles) forms. The emissions and subsequent transport through the atmosphere also cause problems due to air concentrations of the pollutants (e.g., reduced visibility). The precursors to acidic deposition are primarily sulfur dioxides and nitrogen oxides, which are emitted during the combustion of fossil fuels to generate electricity or power motor vehicles. Approximately 70 percent of the sulfur dioxide emissions in the United States and 40 percent of the nitrogen oxide emissions come from coal burning electric generation plants, while 40 percent of the nitrogen oxide emissions come from the transportation sector.

10. National Acid Precipitation Assessment Program, *Integrated Assessment Report*, (Washington, D.C.: 1990).

11. U.S. Environmental Protection Agency, *Toxics in the Community: National and Local Perspectives, 1989.* (September 1991).

12. U.S. Environmental Protection Agency, *Cancer Risk from Outdoor Exposures to Air Toxics*, Report No. EPA-450/1-90-004a, (Research Triangle Park, NC: September 1990).

13. U.S. Environmental Protection Agency, *Report to Congress on Indoor Air Quality*, EPA/400/1-89/01 (August 1989).

14. U.S. Environmental Protection Agency, *A Citizen's Guide to Radon: Protecting Yourself and Your Family from Radon* (Washington, D.C.: 1991) (draft).

15. U.S. Environmental Protection Agency, *FY '89 Enforcement Accomplishments Report*, EPA No. 20E-2001 (February 1990).

16. Brian Pederson and Thomas Cahill, "Ozone at a Remote High-Altitude Site in Sequoia National Park, California," in *Transactions: Effects of Air Pollution on Western Forests*, edited by Richard Olson and Allen Lefohn (Anaheim, CA: Air and Waste Management Association, June 1989).

17. R.M. Adams, S.A. Hamilton and B.A. McCarl, *The Economic Effects of Ozone on Agriculture*, EPA-600/3/84/090 (1984).

18. D.C. Fisher and M. Oppenheimer, "Atmospheric Deposition and the Chesapeake Bay Estuary," *Ambio* vol. 20 (1991): pp. 102-108.

19. U.S. Environmental Protection Agency, *Report to Congress on Indoor Air Quality*, EPA/400/1-89/001C (Washington, D.C.: August 1989).

20. *Radon-Resistant Construction Techniques for New Residential Construction Technical Guidance*, EPA/625/2-91-032 (February 1991), and *Radon-Resistant Residential New Construction*, EPA/6008-88-087 (July 1988), and *Asbestos in Your Home* (Consumer Product Safety Commission and U.S. Environmental Protection Agency, September 1990).

—B—
Climate Change and Stratospheric Ozone Depletion

Climate Change and Stratospheric Ozone Depletion

Two decades ago, most people perceived environmental protection efforts as pollution control at the local, state or national level. Twenty years later, the perception is different. Measurements from Earth-orbiting satellites and other global monitoring programs have provided evidence of humanity's ability to change planetary conditions and processes, largely unwittingly, in the course of daily activity. Two global environmental issues, stratospheric ozone depletion and global climate change, have captured headlines in the popular press, have begun to affect the way people in the United States live their daily lives, and in the process have convinced many people of the global stakes that underlie discussions of economic development and environmental protection.

Stratospheric Ozone Depletion

Initial discoveries

In the mid-1970s, scientists exploring the relationship between chlorofluorocarbons (CFCs) and the stratospheric ozone layer became concerned about indications that this group of manmade chemical substances—used in refrigeration, packaging, fire retardants, computer manufacturing and countless other activities—was eroding an essential atmospheric filter for solar ultraviolet radiation. This discovery began a series of scientific, industrial and political developments that continue some 20 years later. Collectively, these developments have served several functions in the United States, as elsewhere in the world: they reveal humanity's ability to alter the condition of the globe; they also demonstrate that a community of nations can craft dynamic mechanisms to respond to complicated challenges; and they underscore the importance of science as part of the basis for sound public policy.

Scientific evidence of stratospheric ozone depletion has accumulated progressively over time. As the evidence has grown, so has the demand for affordable new technologies, and for national and international policy solutions. In the early 1970s, two teams of U.S. academic researchers, working independently, pieced together the first evidence that indicated the nature of the threat posed by chlorofluorocarbons (CFCs). Richard Stolarski and Ralph Cicerone, working at the University of Michigan, discovered chlorine's ability to destroy ozone in the atmosphere. Mario Molina and Sherwood Rowland, working at the University of California at Irvine, analyzed the lifespans of CFCs and hypothesized that these very stable gases decomposed only in the stratosphere, where their decomposition products would chemically deplete the ozone layer. Subsequent research has supported this view. Research has also suggested that the increased exposure to ultraviolet radiation that could result from the depletion of stratospheric ozone could adversely affect human immune systems, contribute to skin cancers and have other adverse effects on terrestrial and aquatic organisms and natural systems.[1]

Government Responses

On the basis of these initial research findings, in 1978 the United States unilaterally banned the non-essential use of chlorofluorocarbons (CFCs) in aerosol propellants.[2] Few other nations followed the United States' lead in this initiative. In January 1982, the United Nations Environment Program (UNEP) began negotiations for an international framework convention to control the use of ozone-depleting gases. For a variety of reasons, the process moved slowly and with considerable difficulty. First, model-based predictions of ozone depletion had not yet been decisively validated by observational data.

Second, CFCs had long been regarded as miracle chemicals: non-toxic, chemically stable, extraordinarily versatile and effective in their applications, even for such purposes as improving the efficiency of electric devices through better insulation. Furthermore, some nations did not initially agree that CFCs could be replaced by alternative chemicals with less damaging effects on the ozone layer.[3]

Despite the difficulties, in March 1985, 43 nations signed the Vienna Convention, which formally expressed the international community's concern about ozone depletion, stated a goal of reducing use of products harmful to stratospheric ozone, and established mechanisms to incorporate new scientific findings and to create increasingly-specific international controls on ozone-depleting substances.[4]

Later in 1985, after completion of the Vienna Convention, the confidence in model predictions of global ozone depletions increased, and significant evidence of stratospheric ozone depletion came to light. New data confirmed earlier reports of a dramatic springtime loss of ozone over Antarctica (the "Antarctic ozone hole"), and stimulated a more urgent policy response. In 1987, the United States and 23 other nations signed the Montreal Protocol, which committed the parties to reduce uses of CFCs—20 percent by mid-1994 and 50 percent by mid-1999.[5]

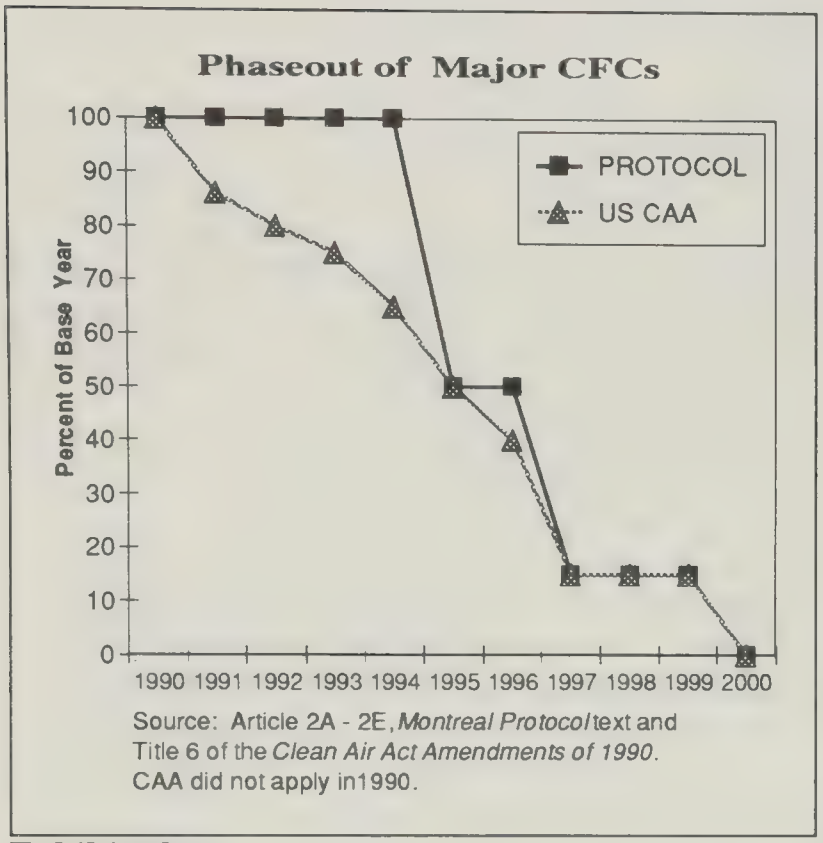
In 1990, at the second meeting of the Montreal Protocol parties, new scientific evidence—in the form of the first observations of global ozone loss—once again led to amendments to the Protocol. These London Amendments provide for CFCs, halons and carbon tetrachloride to be phased out by the year 2000. Methyl chloroform is to be phased out by 2005. In an effort to facilitate a timely transition by developing nations to the use of non-CFC technologies, the United States and other industrialized nations agreed to create a special fund to defray the incremental costs incurred by developing nations making the transition to use of non-CFC technologies.[6] In support of this effort, the U.S. Environmental Protection Agency developed a methodology and undertook country-specific studies aimed at quantifying the needs of individual nations that would be potential recipients of assistance from the new fund.

Supplemental U.S. Responses

In addition to its role in the international arena, as outlined above, the United States also initiated a series of unilateral ozone-protection measures that extend beyond the requirements of the Vienna-Montreal process. First, the federal Clean Air Act (CAA) Amendments of 1990 stepped up the phaseout of several ozone-depleting substances. The 1990 amendments required tougher interim reductions in the phaseout of CFCs, halons and methyl chloroform and, unlike the Protocol, included a production phaseout for hydrochlorofluorocarbons (HCFCs) beginning in 2015, with production to be eliminated by 2030. The CAA amendments directed EPA to establish a national recycling program for CFCs used in refrigerators and air conditioners, prohibited venting of CFCs and HCFCs by mid-1992, and banned deliberate releases of any other environmentally harmful substitute refrigerant after 1995.[7] The United States is using a system of market-based incentives, including tradeable allowances and fees, to implement the phaseout of CFCs, thus achieving reductions on or ahead of schedule at substantially lower costs than would otherwise be incurred.[8]

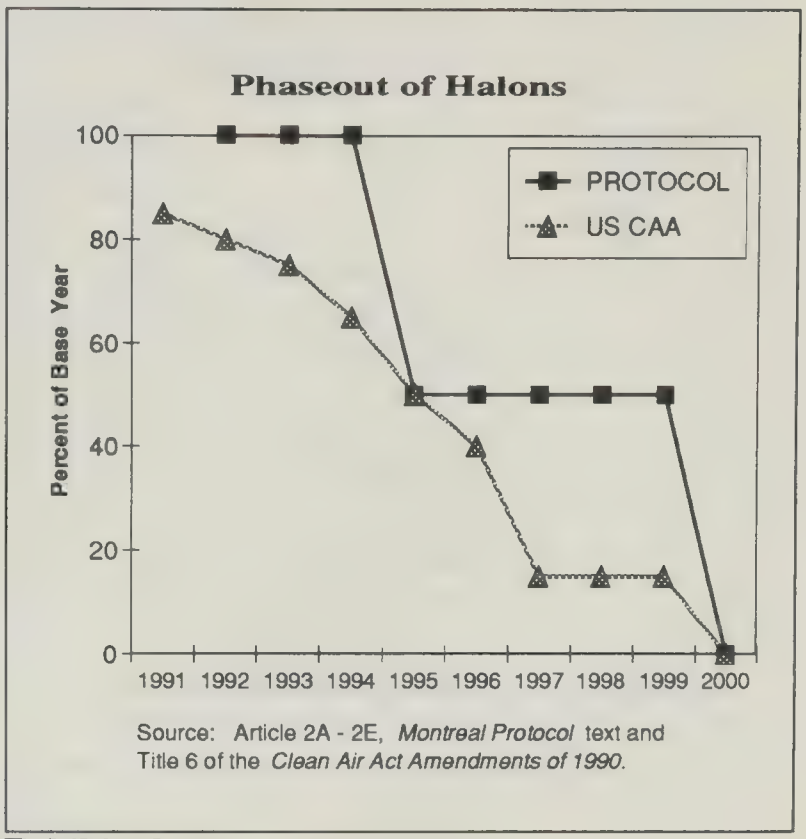
Another U.S. response to the problem of stratospheric ozone depletion has been to undertake vigorous legal enforcement of controls on CFCs. For example, in the first two years after federal regulations implementing the Montreal Protocol took effect, the U.S. government brought enforcement actions against seven violators who imported ozone-depleting chemicals without securing the necessary consumption allowances—the first actions

taken by any nation to enforce the terms of the Montreal Protocol. Violators were fined and required to correct the effects of their actions. As an additional control measure, in the fall of 1990 the United States enacted a tax on ozone-depleting chemicals during the phaseout periods mandated in Montreal and London. In the 12-month period ending June 30, 1990, that tax helped to reduce U.S. CFC production 23 percent below the levels permitted by the amended Montreal Protocol.[9] For the following year (ending June 30, 1991), U.S. CFC production was 42 percent below the required levels.[10] (See Exhibits 6b.1 through 6b.5.)



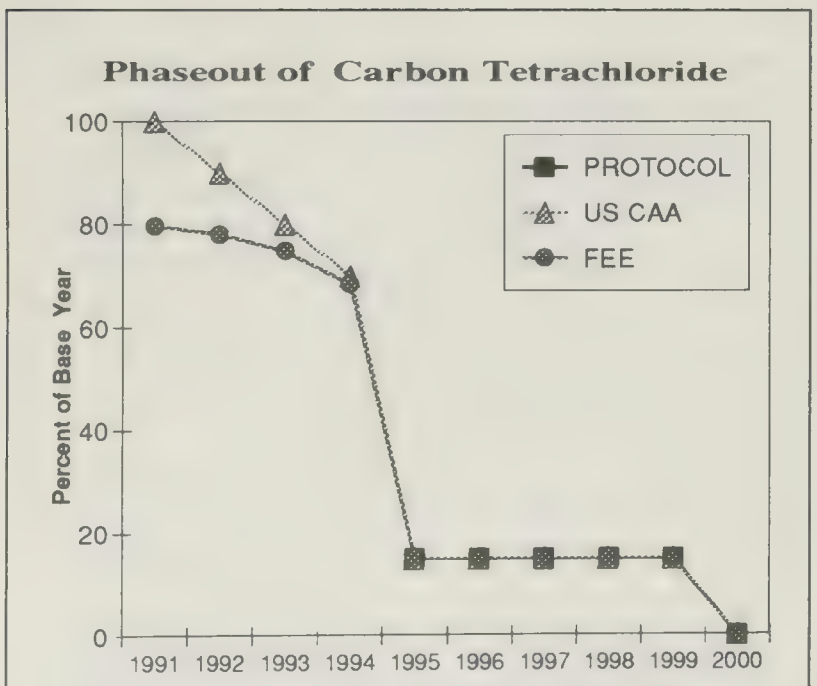
Source: Article 2A - 2E, *Montreal Protocol* text and Title 6 of the *Clean Air Act Amendments of 1990*. CAA did not apply in1990.

Exhibit 6b.1



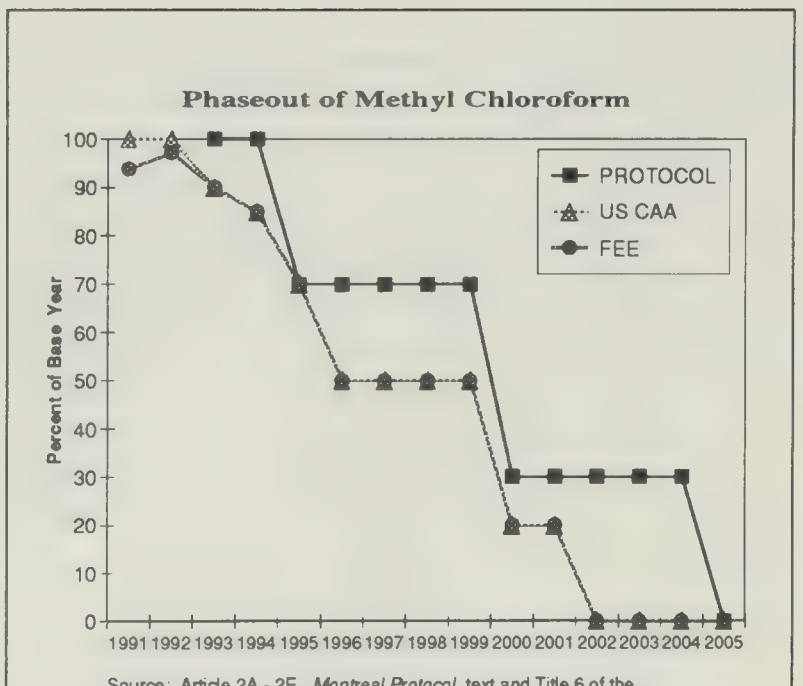
Source: Article 2A - 2E, *Montreal Protocol* text and Title 6 of the *Clean Air Act Amendments of 1990*.

Exhibit 6b.2



Source: Article 2A - 2E, *Montreal Protocol* text and Title 6 of the *Clean Air Act Amendments of 1990*. Production estimates under the User Fee are based on Treasury Department estimates.

Exhibit 6b.3



Source: Article 2A - 2E, *Montreal Protocol* text and Title 6 of the *Clean Air Act Amendments of 1990*. Production estimates under the User Fee are based on Treasury Department estimates

Exhibit 6b.4

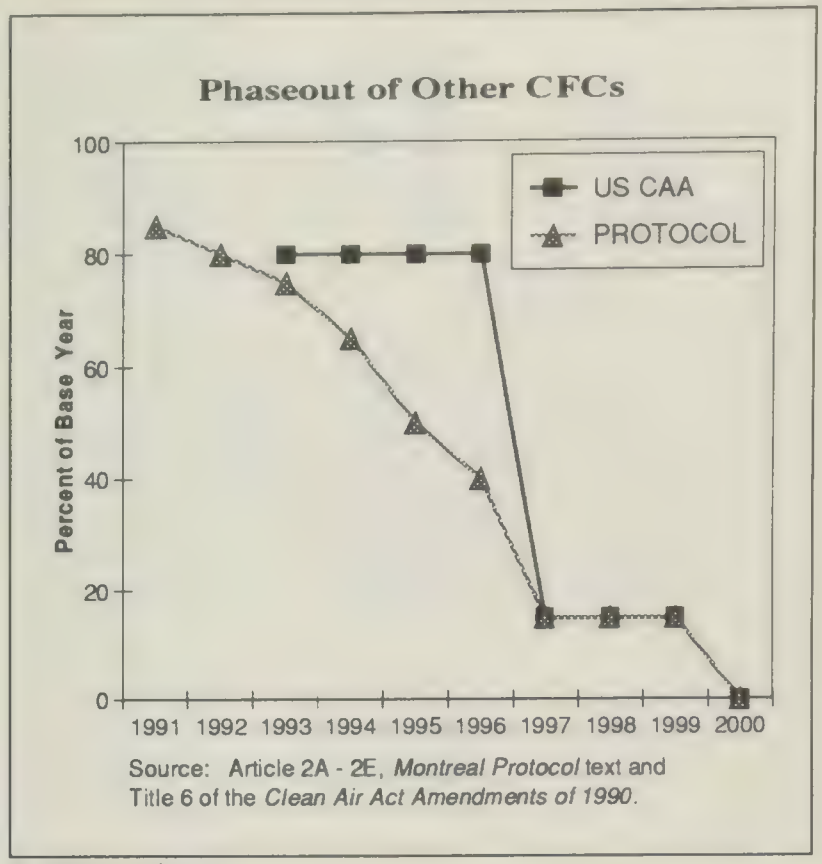


Exhibit 6b.5

U.S.-sponsored scientific research continues to provide a major part of the basis for possible refinement of the global response to stratospheric ozone depletion. Scientists from National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, Department Of Energy and Environmental Protection Agency continue their participation as key members of the international scientific assessment panels established under the Montreal Protocol. In addition, the United States continues to develop new satellite and remote sensing systems which will further improve the international knowledge base on stratospheric ozone. In September 1991, the United States deployed the Upper Atmosphere Research Satellite (UARS), which will provide continuous global measurements of ozone and ozone-depleting substances.

Recent data, provided by systems such as UARS and the Total Ozone Measurement Spectrometer (TOMS), indicate that the ozone layer over densely populated areas of the United States and other countries located between 30 to 60 degrees north latitude has thinned significantly faster than previously projected, especially during late winter months, but also during the spring and summer. The new findings are likely to be accorded close attention during the Montreal Protocol review and re-evaluation efforts scheduled for November 1992.[11] Meanwhile, the United States announced in early 1992 that it would accelerate its phaseout schedule by ending production of CFCs and most other ozone-depleting substances by December 31, 1995, instead of the year 2000, the deadline established by the London Amendments to the Montreal Protocol.

The U.S. private sector also continues to play a prominent role in efforts to respond to the issue of stratospheric ozone depletion. Chemical firms such as E.I. DuPont de Nemours and Allied Signal are actively searching for CFC-alternative compounds that do not pose threats to human health or to the natural environment. DuPont projected during July 1991 that its expenditures for research on CFC substitutes would amount to over $1 thousand-million during the coming decade. Firms in other commercial sectors, particularly manufacturing companies such as General Electric, and electronics companies such as American Telephone and Telegraph (AT&T), are also expending large sums intended to obviate or reduce the need for CFCs and CFC substitutes. For these industries and others, the financial stakes are high: equipment currently dependent on CFCs has been valued at over $135 thousand-million.[12]

Global Climate Change

Responding to potential global climate change has been even more complex than responding to stratospheric ozone depletion. A national response to climate change must reflect the concerns of governments, corporations and citizens about potentially high environmental risks and potentially high economic costs while the science continues to evolve.

Atmospheric greenhouse gases contribute to the heating of the globe by trapping outgoing infrared radiation that would otherwise be radiated to space. Without this basic heat trapping function—popularly referred to as the "greenhouse effect"—our globe would be uninhabitably cold. The key questions, in relation to humanity's impact on the climate system are: the level of scientific confidence in the predictions of enhanced greenhouse warming made by present climate models, and whether any part of the predicted warming has been observed. The First Assessment report by the U.N. Intergovernmental Panel on Climate Change (IPCC), as well as subsequent analyses in the scientific and policy literature, indicate there is substantial evidence that anthropogenic greenhouse gas emissions will provide significantly enhanced warming above the natural baseline.[13] If such predicted warming were actually to occur, the IPCC reports note that substantial negative effects could occur in some areas, including possible changes in sea level, water supply, coastal ecology, frequency and intensity of storms, incidence of droughts, soil moisture and precipitation patterns. Positive impacts might occur in other areas, such as plant productivity and efficiency of water use. Many critical aspects of the predicted warming phenomenon remain unclear, however, especially details regarding timing, extent and regional distribution of future warming. Some aspects of the underlying geophysical processes remain poorly understood, including feedback relationships and the roles of clouds, oceans and biota. The scientific community has concluded that the current temperature trends data cannot be used to verify that an enhanced greenhouse warming has already occurred, nor can it be used to rule out such warming.[14] These uncertainties greatly complicate the understanding of future climate and of its possible impacts on natural and developed systems.

The enhanced greenhouse effect is international in scope. Climatic changes resulting from increases in greenhouse gas emissions would have effects worldwide. Furthermore, greenhouse gas emissions stem from activities around the globe. For example, the National Academy of Sciences estimated in 1983 that about one-fourth of worldwide CO_2 emissions from fossil fuel combustion is contributed by the United States, one-fourth by Western Europe and Japan, one-fourth by the former Soviet Union and Eastern Europe and one-fourth by developing countries.[15] Since that time, industrialized country shares have been declining relative to other regions, with developing countries having the most rapid growth rates.

Greenhouse Gas Sources and Sinks in the United States

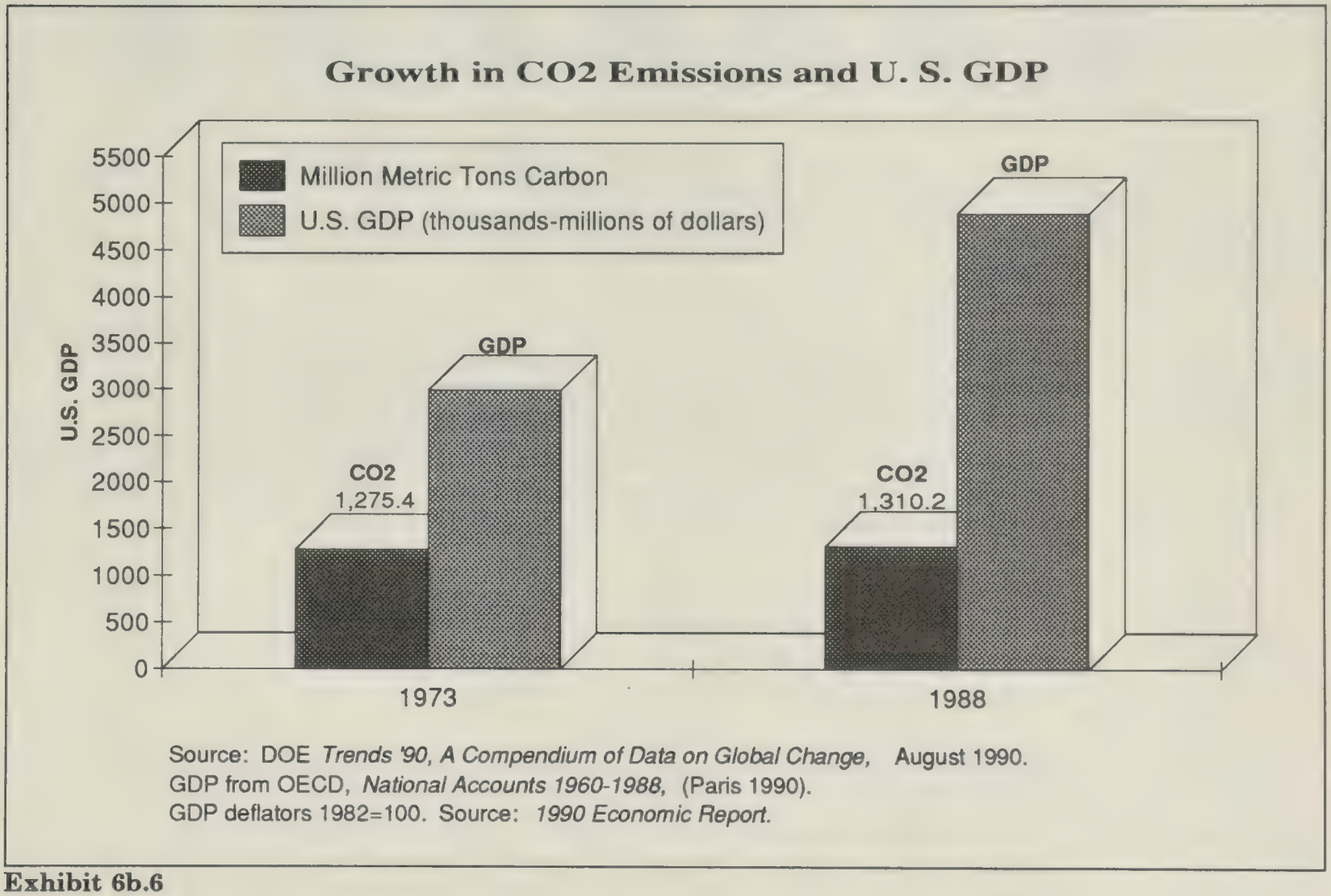
The common greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, chlorofluorocarbons and others. They are produced by a wide variety of activities and processes, many of which are important to economic activity and current lifestyles in every nation, including the United States.[16] Most greenhouse gas emissions, however, occur naturally.[17]

Greenhouse gases are emitted from various sources or stored through incorporation into biological or chemical "sinks." Sources and sinks are the result of countless natural biogeochemical processes as well as day-to-day human activities, including the burning of fossil fuels, industrial production and manufacturing processes, changes in land use, agricultural technologies

and practices, releases of chemical compounds into the atmosphere and biodegradation of waste products.

The United States accounts for a significant portion of global net emissions of greenhouse gases.[18] When measured in absolute terms, the U.S. share amounts to approximately one-fifth of total net greenhouse gas emissions.[19] When viewed in relation to the volume of economic production, U.S. figures resemble those from similar industrialized nations and are lower than those of many Eastern and Central European and developing countries.[20]

The United States has had noteworthy success in recent years in restraining growth in greenhouse gas emissions. Most notably, these successes have been achieved during a period of considerable economic growth. Over the period from 1973 through 1988, the gross domestic product of the United States grew by nearly 50 percent. In the same period, however, U.S. carbon dioxide emissions increased by only 2.7 percent.[21] (See Exhibits 6b.6 and 6b.7)



Source: DOE *Trends '90, A Compendium of Data on Global Change,* August 1990.
GDP from OECD, *National Accounts 1960-1988,* (Paris 1990).
GDP deflators 1982=100. Source: *1990 Economic Report.*

Exhibit 6b.6

U.S. Government Responses

Research. Virtually all aspects of the policy debate about global climate change are significantly affected by the scientific uncertainty associated with predicting the behavior of the ocean-atmosphere-land climate system. The policy debate is further complicated by the highly uncertain socioeconomic dimensions of the issue, such as the costs and benefits of efforts which might be taken to mitigate or adapt to climate change, and even the costs and benefits of potential climate change itself.

To reduce these uncertainties, the U.S. Global Change Research Program (USGCRP) has been developed as a central component of the U.S. approach to global climate change. The USGCRP is an integrated,

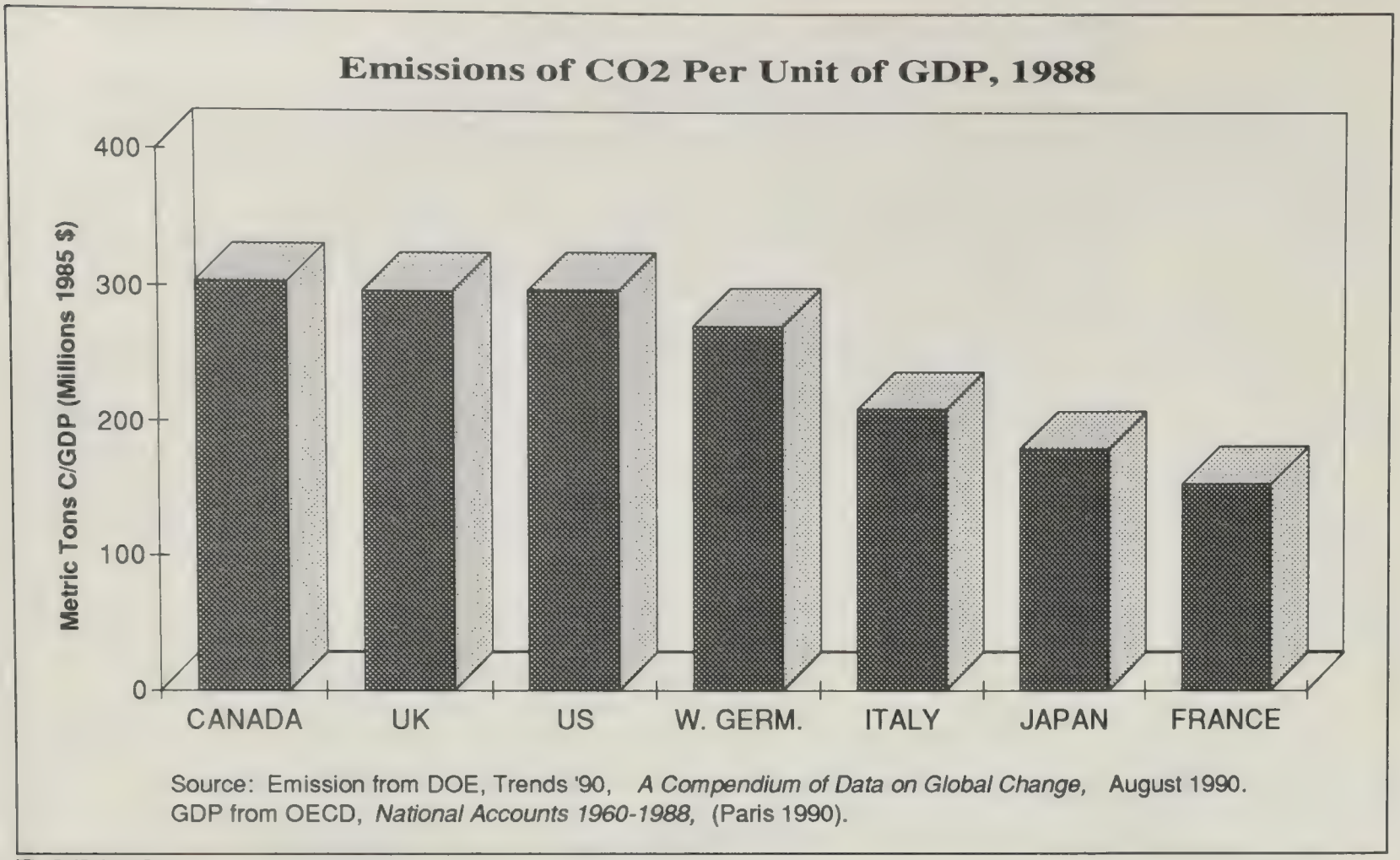


Exhibit 6b.7

interagency research effort involving the extensive technical capabilities of the U.S. government, as well as private researchers operating with government research funds. The long-term goal of the USGCRP is to establish the scientific basis for national and international policy-making relating to natural and human-induced changes in the global climate system. Four high-priority integrating themes have been identified for current natural science research efforts:

- Climate modeling and prediction;
- Global water and energy cycles;
- The global carbon cycle; and
- Ecological systems and population dynamics.

The President's USGCRP budget request for the 1992 fiscal year was $1.2 thousand-million.[22]

Research into potential responses to climate change is coordinated through the interagency Mitigation and Adaptation Research Strategies (MARS) working group. The objective of MARS is to establish the technological, economic and human dynamic bases for efficient, cost-effective global responses. In coordination with both USGCRP and MARS, the United States is also developing an economics research agenda to reduce the uncertainties in this vital area. U.S. research efforts contribute to many worldwide programs sponsored by intergovernmental bodies such as the United Nations Environment Program (UNEP) and the World Meteorological Organization (WMO), and by non-governmental bodies such as the International Council of Scientific Unions. The United States is providing considerable technical expertise, resources and leadership to the IPCC, including acting as chair for IPCC's Response Strategies working group.

National Climate Strategy. In its First Assessment report, the IPCC recommended that nations respond to the accumulating indications of anthropogenic climate change with a variety of actions that could have a beneficial effect in mitigating or adapting to future climate change, but are justified on other grounds, such as reducing air pollution or increasing of energy security.[23]

During 1989 and 1990, the United States introduced a program of actions intended to reduce net greenhouse gas emissions below otherwise projected levels. The major actions included:

- Phasing out chlorofluorocarbons (CFCs) and related gases on a more rapid timetable than that required by the amended Montreal Protocol;

- Providing incentives for energy efficiency and, in turn, reductions in greenhouse gas emissions by placing a permanent ceiling on utility sulfur dioxide emissions at significantly reduced levels, and by giving utilities the flexibility to achieve these reductions by the most cost-effective measures;

- Reducing emissions of air pollutants that are either greenhouse gases themselves or are chemical precursors of greenhouse gases;

- Limiting methane emissions from landfills;

- Seeking a global convention on forests, expanding international cooperation in order to achieve improved stewardship of all of the world's forests for all of their many purposes, including their role as sinks for greenhouse gases;

- Planting an additional one thousand-million trees per year beyond current public and private efforts to plant approximately two thousand-million trees per year, and making other improvements in forest management, thus enhancing sinks for atmospheric carbon dioxide;

- Speeding the adoption of energy-efficient technologies and practices in homes and businesses;

- Promoting the use and further development of non-fossil-fuel energy sources, including solar, nuclear and alternative fuels.[24]

In addition to this initial set of measures, in early 1991 the Bush Administration proposed a National Energy Strategy (NES), which contains other steps that would significantly affect greenhouse gas emissions. The Administration's NES proposal contains components aimed both at increasing the efficiency of overall energy use and at increasing the use of energy produced from sources with relatively low greenhouse gas emissions.[25] As of this writing, legislative proposals to implement the National Energy Strategy are still being debated in the U.S. Congress, with competing proposals expected to have other yields in terms of greenhouse gas emission levels.

If the effect of the Administration's National Energy Strategy proposal are quantified using the global warming potential (GWP) values from the IPCC's 1990 assessment, net greenhouse gas emissions levels would be projected to remain at or below 1987 levels for the reasonably foreseeable future—to the year 2030. As reflected in note 24, however, since the publication of the IPCC's assessment there have been changes in the scientific community's understanding of atmospheric chemistry. These changes, in turn, have raised questions about the reliability of the GWPs on which such projections are based.

NATIONAL ENERGY STRATEGY—KEY ELEMENTS

- *Transportation*—improved energy efficiency through accelerated retirement of older cars; higher limits on tax-free subsidies for use of mass transit; aggressive research and development on new train, electric vehicle, engine and highway technologies.

- *Alternative Fuels and Vehicles*—removal of caps on corporate average fuel economy (CAFE) credits for vehicles with alternative-fuel capabilities; accelerated purchases of alternatively fueled vehicles by federal and private sector fleets; other encouragement for vehicle manufacturers to produce alternatively fueled vehicles.

- *Electricity*—support for integrated resource planning; tax-free treatment of utility-bill discounts for investments in energy conservation; efficiency standards for appliances; efficiency labeling for such products as light bulbs.

- *Buildings*—increased energy efficiency in public housing; efficiency standards for new buildings; incentives for residential efficiency through mortgage financing; higher efficiency at federal facilities.

- *Natural Gas*—improvements in licensing processes and other prerequisites to the production, transmission and use of natural gas.

- *Renewable Energy*—improved ability to maximize hydroelectric output from existing dams; tax credits for investment in solar and geothermal energy, heightened research and development efforts for photovoltaic, wind, solar, thermal, biomass and geothermal technologies; expanded use of waste-to-energy facilities.

- *Nuclear Energy*—new efforts to improve reactor design, reactor safety and nuclear waste disposal, together with streamlined licensing procedures.

- *Clean Coal Technologies*—increased deployment of more efficient clean-coal technologies, in order to reduce carbon dioxide emissions.

Public Responses

The complexities of the global climate change issue—the evolving nature of the science, the potentially deep economic implications and the threat that climate change potentially poses for the globe's natural systems—have made public discussions of climate policy fiercely contentious. Debates in the United States have taken place almost continuously at every level of government. In addition to the federal-level activity outlined above, interest groups, policy centers, political candidates, private companies, cities, towns and private citizens have joined the debate. They have led to independent analytical studies, legislative initiatives, local policies, industry initiatives, opinion-page newspaper articles and documentary films.[26]

Some observers have suggested that public interest in the United States was enhanced by the record-breaking heat and drought of the summer of 1988.[27] Following that summer, Congress held numerous hearings and the popular press published many articles about "the Greenhouse Effect." Since that time, global climate change has retained the attention of the

general public. In fact, public opinion polling data typically indicate that the majority of the population views global climate change as a serious potential threat to natural systems and to lifestyles in the United States.[28]

State Government Responses

Several state governments have developed responses to climate change. Their programs include the establishment of climate-change task forces and commissions, promotion of energy efficiency and the use of non-fossil fuels, encouragement of transportation efficiency and tree planting, and examination of anticipatory adaptation measures. The following is a partial listing of some of these state programs:

Arizona	Initiated a variety of solar energy demonstration projects, including solar street lamp systems in rural cities and towns, and a planned solar community.
Arkansas	Established the "Plant the Future" program to plant 10 million trees per year and reduce the "urban heat island" effect. Established a policy of "no net loss of forest land."
Connecticut	Passed "An Act Concerning Global Warming " (1990), which establishes a broad range of energy conservation measures, including promotion of mass transit and carpooling, revisions to the building code to maximize energy efficiency and requirements that the state purchase energy-efficient appliances and vehicles.
Maine	Established restrictions on the location, size and density of development to prevent future hazards due to possible sea-level rise and shoreline retreat.
Massachusetts	Developed a system for incorporating the externality cost of greenhouse gas emissions into Department of Public Utilities review, analysis and planning activities.
Missouri	Initiated Operation TREE, an afforestation (planting new forest) and reforestation program aimed at reducing soil degradation and heating and cooling demand; started a "Used Paper to Trees" program through which residents receive tree saplings in return for recycling newspaper.
Oregon	Conducted a comprehensive study process involving all state agencies. Developed policy recommendations for state programs in transportation, building energy efficiency, forestry and other areas.
Vermont	Set a goal to reduce greenhouse gas emissions by 15 percent and reduce per capita nonrenewable energy consumption by 20 percent by the year 2000. The plan includes $20 million in new energy-efficiency fees.[29]

Businesses

The U.S. private sector has recognized that global climate change is a serious issue. Different industries and firms have developed widely varied responses including:

- Participation in domestic and international scientific research and public education efforts;

- Establishment of industry coalitions and informal groupings to monitor scientific, domestic legislative and international treaty processes;

- Development of practices, products and services which are beneficial for mitigating or adapting to climate change but which are justified on other grounds;

- Development of products and services that are justified explicitly on the basis of their contributions to the mitigation of, or adaptation to, global climate change; and

- Development of public-private partnerships to adopt practices which are beneficial for mitigation of, or adaptation to, climate change.

Many U.S. firms and trade associations have participated very actively in scientific and educational efforts. One industry association which has been particularly active is the Electric Power Research Institute (EPRI). EPRI has sponsored independent studies, worked in conjunction with U.S. government technical agencies and participated in the IPCC assessment effort.[30] The Global Climate Coalition is an ad hoc association of organizations and individual companies. Like EPRI, the Coalition has participated in the IPCC process. They have also monitored the work of the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change and provided an information exchange channel among U.S. government officials, legislators and the Coalition's membership.

A variety of companies are actively pursuing internal programs which will reduce their greenhouse gas emissions. In many cases, the firms are concentrating on activities that are justifiable on other grounds which bring economic benefits. As a part of a corporate-wide pollution prevention effort, for example, Dow Chemical's Louisiana Division has saved over 1 million-million Btus of energy in the last nine years.

Several electric utilities have introduced programs to encourage end-user efficiency and thus control demand for increased generating capacity, which would cause increased greenhouse gas emissions. The New England Electric Company and Pacific Gas and Electric (PG&E) are two firms that have had long-running demand-side management programs. In both cases, the results have been noteworthy on both environmental and economic bases. PG&E's program is summarized in Chapter 4.[31]

One of the major partnerships of the public and private sectors is the Green Lights program, developed and implemented by the U.S. Environmental Protection Agency. Green Lights brings together the federal government, state governments and major corporations to make corporate lighting more energy efficient. By late 1991, over 120 firms had joined Green Lights.

Few U.S. companies currently market the benefits of their products in mitigating or adapting to future climate change. However, in the spring of 1991 Southern California Edison and the Los Angeles Water and Power Authority established a demand-side management program that was presented explicitly in terms of its potential to reduce carbon dioxide emissions.[32] Another company that does market greenhouse-gas reduction benefits is General Electric, which notes these characteristics in advertisements for some of its product lines, including high-efficiency compact fluorescent light bulbs. Another company is Weyerhauser, which is developing drought- and heat-resistant trees that would be effective at adapting to possible future climate.

Some companies are also implementing programs designed to offset emissions from their production. Applied Energy Systems (AES), for example, is sponsoring conservation of tropical rain forests in Guatemala and Paraguay to offset emissions from new coal-fired electric power plants.

Endnotes:

1. Richard S. Stolarski and Ralph J. Cicerone, "Stratospheric Chlorine: A Possible Sink for Ozone," in *Canadian Journal of Chemistry* vol. 52 (1974): pp. 1610-15. Also: Mario J. Molina and F. Sherwood Rowland, "Stratospheric Sink for Chlorofluoromethanes: Chlorine Atomic Catalysed Destruction of Ozone," in *Nature* vol. 249 (1974): pp. 810-812.
2. 42 U.S.C., section 7457(b).
3. Richard Benedick, *Ozone Diplomacy* (Cambridge, MA: Harvard University, 1991).
4. Convention for the protection of the ozone layer, with annexes. Done in Vienna, Austria. March 22, 1985; entered into force September 22, 1988.
5. For a discussion of the Antarctic ozone losses, see Susan Solomon, "The Mystery of the Antarctic Ozone Hole," *Reviews of Geophysics* vol. 26 no. 1 (1988). For the subsequent revision of the Vienna Convention, see Montreal Protocol on substances that deplete the ozone layer, with annex. Done at Montreal September 16, 1987; entered into force January 1, 1988.
6. The United States agreed to the creation of the fund specifically because important conditions were met: scientific evidence was sufficient to determine clearly the causes and effects of ozone depletion; the Protocol's measures were expected to address this problem successfully; the resources needed by developing countries were deemed to be "reasonable and predictable." See "Statement by the Chief of Staff," White House Press Office, June 15, 1990.
7. 1990 Clean Air Act Amendments, Public Law 101-549. 104 Stat 2399.
8. U.S. Environmental Protection Agency, "Protection of Stratospheric Ozone," 53 *Federal Register* 30, 566 (1988) and 53 *Federal Register* 30, 604 (1988).
9. Budget Reconciliation Act of 1990. Public Law 101-508. 104 Stat. 1388.
10. Conversation with officials of the U.S. Environmental Protection Agency.
11. Richard Stolarski, Peter Bloomfield and Richard McPeters, "Total Ozone Trends Deduced from Nimbus 7 TOMS Data," *Geophysical Research Letters* vol. 18 no. 6 (June 1991): pp-1015-1018.
12. William K. Stevens, "Ozone Layer Thinner, but Forces Are in Place for Slow Improvement," *The New York Times*, April 9, 1991, p. C4. Also, see: Malcolm W. Browne, "Grappling with the Cost of Saving Earth's Ozone," *The New York Times*, July 17, 1991, p. C1. Also, see Andrew Pollack, "Moving Fast to Protect Ozone Layer," *The New York Times*, May 15, 1991 p. D1.
13. As one example, the IPCC's First Assessment Report stated, in its "Overview" section, that the panel was "certain" that increases in atmospheric concentrations of greenhouse gases "will enhance the greenhouse effect, resulting on average in an additional warming of the Earth's surface. The main greenhouse gas—water vapor—will increase in response to global warming and further enhance it." See J.T. Houghton, G.J. Jenkins and J.J. Ephraums, editors, *Climate Change: The IPCC Scientific Assessment*, (Cambridge University, 1990) p. xi.
14. Currently available global mean temperature data do indicate a warming trend. That trend, however, falls within the bounds of both natural climate variation, and of model projections for anthropogenic climate change. The world scientific community has debated, and continues to debate, the origins of the warming trend which has been observed over the last decade. Is it naturally caused cyclical change, or anthropogenic warming? Or is

anthropogenic warming either partially masked or accentuated by cyclical change? For discussion of this issue in the scientific literature, see Houghton et al. *Climate Change*. U.S. scientists and policy makers have also been vocal participants in this heated debate. See the following for additional discussion: D. Allan Bromley, "The Making of a Greenhouse Policy," *Issues in Science and Technology* (National Academy of Sciences, Fall 1990), pp. 55-61. Robert M. White, "The Great Climate Debate," *Scientific American* vol. 263 no. 1 (July 1990): pp. 36-43. Stephen H. Schneider, "The Changing Climate," *Scientific American* (September 1989). Fred S. Singer, "No Scientific Consensus on Greenhouse Warming," *The Wall Street Journal* (September 23, 1991). Patrick Michaels, "The Greenhouse Climate of Fear," *The Washington Post* (January 8, 1989), Sunday, Final Edition, p. C3.

15. National Academy of Sciences, National Research Council, Carbon Dioxide Assessment Committee, *Changing Climate* (Washington, D.C., 1983). It should be noted that emissions from fossil fuel combustion, which is itself only one of the practices affecting net emissions of greenhouse gases, are by definition most frequently associated with industrialized economies.

16. J. Smith, and D. Tirpak, eds. *Potential Effects of Global Climate Change on the United States*, chapter 2 (Washington, D.C.: U.S. Environmental Protection Agency, 1989). Also, see U.S. Department of Justice, "A Comprehensive Approach to Addressing Potential Climate Change: Report of the Task Force on the Comprehensive Approach to Climate Change" (Washington, D.C., February 1991): p. 30, Table 4. Greenhouse gases also play other roles, unrelated to climate change, and these roles can lead to either positive or negative environmental impacts. CFCs, for example, deplete stratospheric ozone. Atmospheric carbon dioxide has a "fertilizer" effect on plant growth in that it improves the efficiency of plant photosynthesis and water use. As is noted in the air quality section of this report, volatile organic compounds are in some cases also precursors of greenhouse gases, which contribute to urban air quality problems, although the quantitative links are not fully understood.

17. CFCs, HCFCs, halons and other related ozone-depleting substances do not naturally occur in the biosphere.

18. The term "net emissions" is defined as the difference between greenhouse gas emissions from "sources" and storage in "sinks." See U.S. Department of Justice, "A Comprehensive Approach to Addressing Potential Climate Change: Report of the Task Force on the Comprehensive Approach to Climate Change" (Washington, D.C., February 1991): p. 31.

19. Figures for total emissions are calculated in a variety of ways, with varying results depending on which gases are counted, and which global warming potential (GWP) and atmospheric residence values are used. The most frequently used GWP and atmospheric residence values have been the IPCC's figures, based on the 100-year lifetime. See note 24 for a discussion of evolving science and its implications for GWPs. For one example of total net emissions of greenhouse gases, see The World Resources Institute, *World Resources 1990-1991* (New York and London: Oxford University Press, 1990).

20. Patterns of individual nations' net emissions reflect a multitude of factors. For example, the composition of a nation's economic output will affect net emissions depending on the degree to which major producing sectors require high or low levels of energy inputs per unit of output, and depending on whether or not the energy resources available to provide for those energy needs are relatively high in emissions or not. As another example, a nation's relative propensity to invest in and use mass transit systems, which offer energy-efficiency improvements by comparison to use of personal automobiles, reflect a variety of factors ranging from population density and legislative structures, to sociological considerations and energy prices. See "America's Climate Change Strategy: An Action Agenda" (The White House, February 1991).

21. For data and discussion of U.S. carbon dioxide emission trends, see Thomas A. Boden, Paul Kanciruk and Michael P. Farrell, editors, *Trends '90: A Compendium of Data on Global Change* (Oak Ridge National Laboratory, Environmental Sciences Division, Carbon Dioxide Information Analysis Center, August 1990): pp. 94-95.

22. The U.S. government's fiscal year (FY) 1992 runs from October 1, 1991, through September 30, 1992. See U.S. Government Printing Office, *Our Changing Planet: The FY 1992 U.S. Global Change Research Program, A Supplement to the U.S. President's Fiscal Year 1992 Budget* (Washington, D.C.: 1991).

23. This principle has come to be known popularly as the "No Regrets" approach. The approach was first outlined in a speech by U.S. Secretary of State James Baker in which he said, "...We can probably not afford to wait until all of the uncertainties have been resolved before we do act. Time will not make the problem go away....We should focus immediately on prudent steps that are already justified on grounds other than climate change." James A. Baker, III, "Remarks before the Response Strategies Working Group, Intergovernmental Panel on Climate Change, January 30, 1989. For IPCC's response strategies, see *Climate Change: The IPCC Response Strategies*, (Washington, D.C.: Island Press, 1990,) pp. xxxiv-xxxv.

24. On the basis of the 100-year lifetime global warming potential (GWP) values in the IPCC's 1990 First Assessment Report, the United States calculated that these actions would result in net greenhouse gas emissions in the year 2000 being equal to or below 1987 levels. In light of on-going advances in state-of-the-art atmospheric chemistry, however, these GWP values are subject to discussion and even significant change. For the 1990 IPCC GWP values, see J.T. Houghton, G.J. Jenkins, and J.J. Ephraums, editors, *Climate Change: The IPCC Scientific Assessment,* (Cambridge University, 1990). For projections of the changes in the United States' net emissions based on the IPCC GWPs, see "America's Climate Change Strategy: An Action Agenda," (The White House, February 1991): p. 2; Alex Cristofaro and Joel Scheraga, "The Cost of Reducing Greenhouse Gas Emissions in the United States," (U.S. Environmental Protection Agency, December 1990). For discussion of some of the possible changes in the GWPs subsequent to the publication of the IPCC assessment, see "Scientific Assessment of Stratospheric Ozone, 1991: Executive Summary" (U.N. Environmental Program, October 22, 1991).

25. U.S. Government Printing Office, *National Energy Strategy: Powerful Ideas for America*, First Edition, 1991/1992, (Washington, D.C.: 1991).

26. For examples of the independent scholarly studies, see the reports of the Synthesis, Mitigation, and Adaptation panels under the common title *Policy Implications of Greenhouse Warming,* (Washington, D.C.: National Academy Press, 1991). For an example of the roles played by non-governmental environmental organizations, the academic research community, and the national legislative process, see William D. Nordhaus, "Uncertainties and Research Priorities in Global Environmental Issues," Testimony before the House Committee on Science, Space and Technology: Subcommittee on Science, October 8, 1991; see also Daniel J. Dudek, "Offsetting CO_2 Emissions: Building a Comprehensive Global Greenhouse Gas Market," Statement before the House Subcommittee on Energy and Power, June 19, 1991.

27. Robert M. White, "The Great Climate Debate," in *Scientific American* vol. 263 no. 1 (July 1990): pp. 36-43. See also Michael D. Lemonick, "Feeling the Heat" *Time* (January 2, 1989). Also, "From the Publisher" in *Time*, "Planet of the Year" (January 2, 1989); Patrick Michaels, "Greenhouse Climate of Fear," *The Washington Post* (January 8, 1989); William K. Stevens, "With Cloudy Crystal Balls, Scientists Race to Assess Global Warming," *The New York Times* (February 7, 1989); William Booth, "So What if it's Getting Hot?" *The Washington Post* (September 22, 1991).

28. Survey data generally indicate a public perception of global climate change as a serious policy issue. The level of public concern varies from one survey to the next, however. In addition, frequent misperceptions of some of the causes of increased radiative forcing indicate some of the pitfalls in understanding and responding to complicated policy issues. For an example of surveys showing high levels of public concern, see the second national survey on environmental issues by Environment Opinion Study, Inc., "EOS2" (June 1991): p. 21, in which 56 percent of the group polled listed global climate change as either "very serious" or "extremely serious." For a survey showing some of the popular misperceptions of current climate science, see John Doble, Amy Richardson and Allen Danks, *Science and*

the Public: A Report in Three Volumes. Volume Three: "Global Warming Caused by the Greenhouse Effect," (The Kettering Foundation, June 1990), p. 95, Table 14. This multi-stage study found that, even after an informational briefing, 36 percent of survey participants believed incorrectly that pollution or emissions from nuclear power contributed to the greenhouse effect.

29. For a more complete review, see Barbara Wells, *Curbing Climate Change through State Initiatives: State Policy Reports,* (Washington, D.C.: National Governors' Association, May 1991). Also: National Governors' Association, "Environmental Research and Technical Assistance Report" (Washington, D.C., Summer 1991). Also: Andrew Silbiger and Nancy Gonring, "Selected Summary of Current State Responses to Climate Change" (Washington, D.C.: U.S. Environmental Protection Agency, January 1991).

30. Chauncey Starr and Milton F. Searl, "Global Energy of the 21st Century: Role of Energy and Electricity Alternatives," Electric Power Research Institute, paper prepared for the ENS/ANS-FORATOM Meeting, Lyon, France, September 23-28, 1990.

31. PG&E and NEE have justified their programs on the grounds that it is cheaper to increase generating capacity through demand reduction than it is through the actual building of new generating capacity.

32. "Southern California Edison Initiates CO_2 Emissions Reductions; No Regrets Plan May Help Prevent Potential Global Warming," news release, May 20, 1991.

—C—
Freshwater and Wetlands

Overview

The development of America's water resources has been a key to the growth and prosperity of the United States. Water resources have been developed for navigation, domestic water and industrial supplies, agriculture and water power. These uses of the nation's water resources have enabled cities in arid regions to bloom, allowed crops to grow in semi-arid areas and provided low-cost electricity to spur agricultural and industrial development.[1]

In the process, most of the nation's rivers, lakes and other aquatic habitats have been altered. Large portions of free-flowing rivers became reservoirs or were otherwise diverted. Water quality, related land resources and in-stream ecosystems have been degraded. Fish and wildlife populations have changed accordingly. Anadromous fish populations declined because adults could no longer reach their natural spawning grounds or downstream migrants could not reach the sea. Accordingly, in the 1970s, U.S. water policy began to emphasize correcting water pollution problems, while promoting new water development received less emphasis.

In the early 1970s, the United States was faced with immense water pollution problems: untreated sewage in the Potomac River and Boston Harbor, toxic waste in the Mississippi, Ohio and Cuyahoga Rivers, massive algae blooms in Lake Erie, declining fish and shellfish populations in the Chesapeake Bay and similar problems that were evident throughout the country. Since the passage of the Clean Water Act in 1972, the United States has invested heavily in improving the quality of its waterways to make them "fishable and swimmable." The bulk of these investments has been for the treatment of industrial and municipal sewage discharges. Most of the more obvious pollution problems now have been corrected—rivers and lakes no longer are used indiscriminately for the discharge of wastes, and waters that were severely degraded 20 years ago have recovered in some measure.

Despite these successes, the goals of the Clean Water Act have not been fully achieved. Many waters remain polluted even after federal and state programs successfully reduced the discharges of "conventional" pollutants such as bacteria, oxygen-demanding substances, suspended solids, and oil and grease from industry and sewage treatment plants. Our attention has therefore broadened to include other types of sources and pollutants such as sediment, nutrients and pesticides in urban and farm runoff, and metals and other toxic substances from all sources.

Today, federal and state water quality agencies are especially concerned with diffuse pollution sources (often, called "non-point" sources to distinguish them from "point," or end-of-pipe sources such as agricultural and urban runoff. As more is learned about the fate and transport of toxic substances, the complex interactions of such pollutants in the environment have also been concerns. These substances may travel long distances and accumulate in the food chain, leading to long-term adverse effects on many species, including fish, amphibians, birds and mammals and, ultimately, humans. Increasing urban and residential development can threaten critical natural habitat, especially in wetlands and coastal areas, by increasing surface runoff, depleting groundwater, and polluting the water. Expanding urban populations also lead to increased demand for clean water for drinking and other uses that support daily life.

Among the challenges facing the U.S. water quality program in the 1990s is maintaining the gains of the last 20 years while also tackling the unique problems facing individual watersheds. Some officials believe it may be necessary to supplement the basic nationwide regulatory program with targeted geographic approaches based on locally developed and applied solutions. Resolution of many remaining water quality problems will require

consideration of the impacts of local land use decisions, and these solutions are most appropriately designed at the local and state levels.

To address these water quality problems, diverse approaches are needed. These will necessarily be strategies that combine new and existing tools, including economic incentives, voluntary approaches, pollution prevention, targeted regulatory requirements, creative enforcement initiatives, public education, outreach and technical assistance to state and local governments, and improved science and technology. These strategies will be applied to such problems as controlling non-point source runoff, reducing toxic pollution from both point and non-point sources, protecting aquatic ecosystems and preventing habitat destruction, and to restoring critical habitats such as wetlands, estuaries, lakes and rivers.

This section begins with a review of water use, and a discussion of future water needs and availability; followed by a summary of specific issues relating to the uses, quality and condition of surface waters (rivers, lakes and streams), groundwater, drinking-water supplies and wetlands.

Trends in Water Use and Availability

The nation's freshwater needs are met by withdrawals from streams, rivers, lakes, reservoirs, and groundwater aquifers. These withdrawals are referred to collectively as offstream water use. (See Exhibit 6c.1.)[2] The water supply of the 48 conterminous United States available for non-consumptive uses amounts to about 5,244 thousand-million liters per day. Even though total offstream withdrawals of surface water more than doubled from 1950 to 1980, withdrawals still remained less than 21 percent of the renewable supply in 1980.[3] Chronic water shortages persist in some localities, however, and some areas of the country experience intermittent water shortages during periods of drought. In the more arid sections of the western United States, there is increasing competition for water, not only as drinking water for growing urban populations, but also for industry, agriculture, recreation and support of natural ecosystems. The flows of many streams in this part of the country are fully allocated to current users, limiting opportunities for water use by any major new facilities. In other locations where the quantity of surface or groundwater is sufficient, its quality may make desired uses impractical.

Surface Water

Surface water supplies about half the nation's drinking water and is the major source of water for irrigation and the generation of electricity. Rivers and lakes also support fisheries and wildlife habitats and provide recreational opportunities for tens of millions of people each year.

Surface water continues to be the primary source of the nation's freshwater supplies; however, its relative significance compared to groundwater varies across the nation. In only 10 states does surface water provide less than half of the total withdrawals. Eleven states withdraw more than 38 thousand-million liters per day of surface water for all offstream uses and account for about 52 percent of the total surface water withdrawals in the United States. The largest withdrawals of surface water occur in California, Illinois, Pennsylvania and Michigan.

Since 1965, thermoelectric power facilities have exceeded irrigation as the largest category of water withdrawals for offstream use.[4] (See Exhibit 6c.2.) Recently, water conservation measures and a reduction in once-through cooling have led to a slowdown in the increasing rate of water use for power generation. Increases in recycling of power-plant cooling water through the

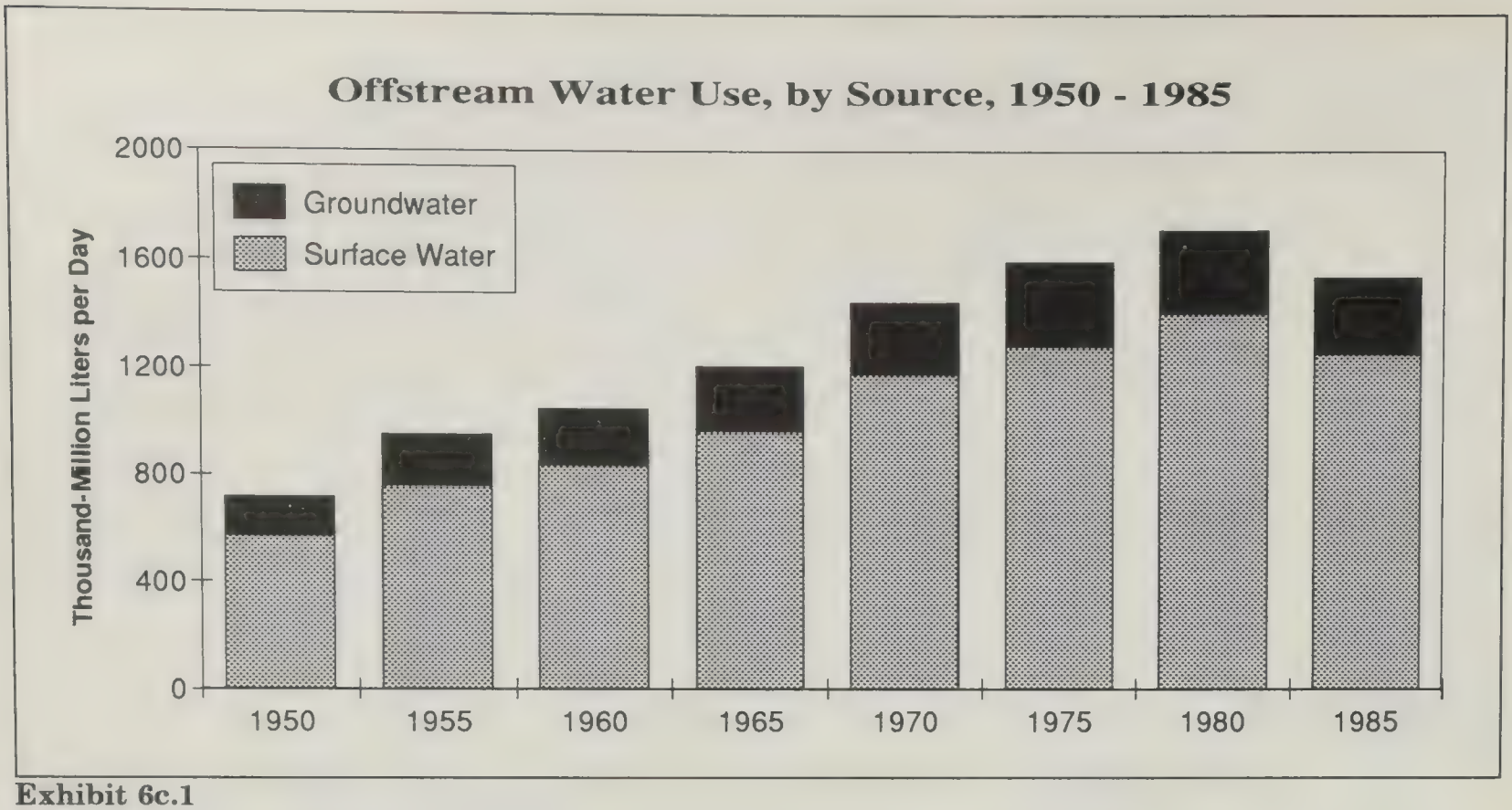


Exhibit 6c.1

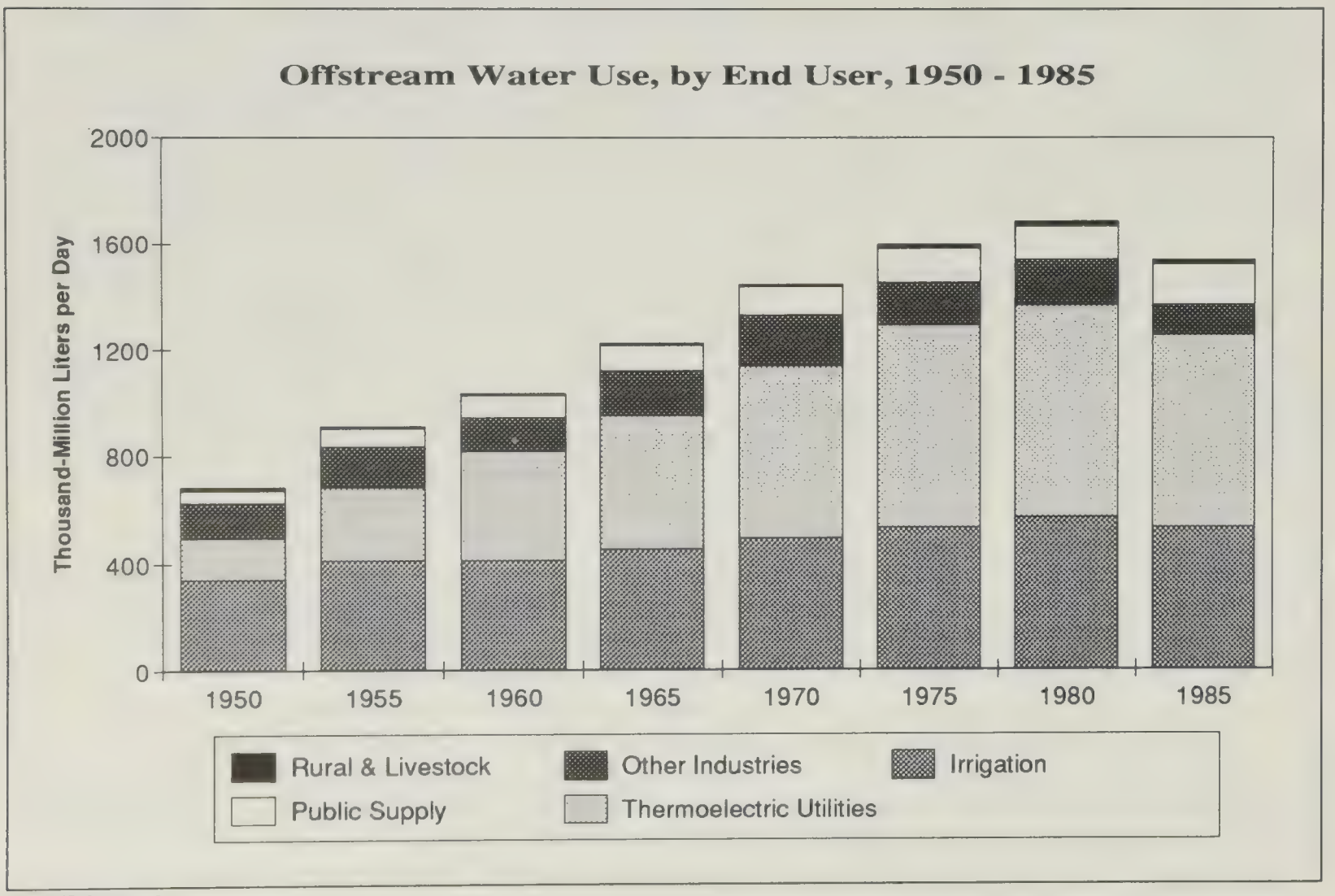


Exhibit 6c.2

use of cooling towers should further slow the rate of water withdrawal, but probably will increase consumptive use as a result of evaporative losses from the towers.

In 1985, irrigation withdrawals accounted for 34 percent of total water withdrawal and 80 percent of all consumptive water use in the United States. Much of the consumptive use resulted from conveyance loss between streams or reservoirs and the fields being irrigated, as well as from losses associated with inefficient water application techniques and schedules. Improvements in irrigation methods and reduction in irrigated cropland area are responsible for declines in irrigation water use between 1980 and 1985.[5]

In contrast to other water uses, public supply (water withdrawn by public and private suppliers for domestic, commercial and industrial purposes) and rural and livestock use (includes self-supplied domestic uses plus livestock, dairy sanitation, and other farm uses) have continued to increase. This increase mirrors population growth and reflects an increase in population served. Water usage may stabilize or decline in the future as water costs rise, more water conservation measures are adopted and public awareness of the need to conserve water improves.

Groundwater

Since 1950, the percentage of total U.S. water supply provided by groundwater has been increasing for most uses except thermoelectric power generation. Although groundwater is available nearly everywhere in the United States, the quantity and quality available and the conditions controlling its occurrence and development differ from one part of the nation to another. States with the largest groundwater use are in the West and Midwest—Arizona, California, Idaho, Kansas, Nebraska and Texas, where irrigated agriculture is common. In the East, states that use large amounts of groundwater for irrigation include Arkansas, Florida, Louisiana and Mississippi.[6]

The effects of groundwater use vary from place to place. In water-deficient areas, such as southern Arizona and the southern High Plains region, very large volumes of groundwater continue to be withdrawn to supply agricultural and municipal needs; these withdrawals cannot be sustained indefinitely. In Florida and the Atlantic Coastal Plain, groundwater development has redistributed natural flow patterns and caused sinkholes, salt water intrusion and land surface subsidence. In parts of the San Joaquin Valley of California, groundwater mining has resulted in sediment compaction and land subsidence over a total area of several thousand square kilometers.[7]

Changes in water levels in wells reflect changes in the amount of groundwater in storage. In parts of Texas, New Mexico, Arizona and California, long-term withdrawals of large volumes of groundwater, primarily for agriculture, have resulted in widespread declines in water levels by 12 meters or more.[8] In some of these areas, the decline in water level took place many years ago and the water table has since stabilized at a lower level. In other areas, reductions in water levels are recent events and are continuing. In some locations in the western United States the declining groundwater tables are causing the loss of base flow in streams and rivers, which in turn results in the decline or death of riparian and wetland plant communities, increased soil erosion, channel incision and a loss of stream channel stability.

Issues in Water Demand and Supply

Most existing flood control and reclamation projects in the United States were authorized and developed when the national focus was on river flow management and the development of dependable water power supplies. The federal government's role in water development began in the late 19th and early 20th century, through public works programs, as part of a national goal to settle the Western states and territories.

While reclamation and flood control projects have contributed to new recreational activities and produced new habitat for some fish and wildlife species, these projects have sometimes directly or indirectly resulted in losses and degradation of important wetlands and other natural habitat of fish and wildlife. For example, agricultural and flood control activity, largely supported by federal and state water development projects, have contributed to the loss of approximately 90 percent of the original wetland area in California's Central Valley, many of which were seasonal wetlands that depended on spring flooding.[9]

The original statutory goals for federal reclamation projects were to foster economic development and growth; these goals must now be balanced with a growing consideration of the value of fish and wildlife and broader environmental goals. The passage of the Fish and Wildlife Coordination Act of 1934 and the 1965 Water Resources Planning Act began the process of improving the balance. The two laws were the first to introduce a more comprehensive approach to federal water resources planning. Later, the National Environmental Policy Act in 1969, and the Endangered Species Act of 1973, required that planners consider the impacts of proposed projects on the environment and endangered species, and of alternatives to avoid or minimize them, during planning stage.

In the future, more emphasis will be placed on increasing the efficiency and effectiveness of water resource use as a means of meeting increased needs for fresh water, rather than on constructing new supply projects. The growth in reservoir storage capacity began to level off about 1970, indicating that the trend has already begun. Nonstructural methods available for increasing the efficient use of available water supplies include conservation, voluntary reallocation of water through market transfers, reuse, reduction of evapotranspiration loss, improved water-system management, and greater utilization of groundwater reservoirs through conjunctive use of groundwater and surface-water resources.

State and local government attention recently has been focused on conservation and more efficient use of existing supplies of both surface and groundwater. Most water rights are administered by state governments, and some states have modified their laws to facilitate voluntary water transfers among existing uses, either with short-term leases or permanent sales. These transfers can provide not only a source of water for developing uses, but also economic incentives and funding for conservation in existing uses.[10] In 1988, the federal government, which supplies irrigation water to about 20 percent of the irrigated land in 17 Western states, adopted a policy to facilitate trading of water delivered through its facilities. This policy reflects a broader shift in the federal government's approach to water policy, begun in the late 1980s, away from large federally financed agricultural projects and towards a more comprehensive resource management approach.

Surface Water Quality: Rivers, Lakes and Streams

Surface water in U.S. rivers, lakes, reservoirs and streams provides drinking water for approximately half of the nation's 250 million people, supports fisheries and valuable habitats for living resources, and provides recreational opportunities, aesthetic pleasure and sources of water for daily use by people, industry, power plants, agriculture and for a multitude of other purposes.

For the past 20 years, all levels of government in the United States have been working with industry and citizens to make America's surface waters fishable and swimmable. From 1972 through 1990 a total of approximately $50 thousand-million in federal grant assistance has been

CASE STUDY

TRANSFER OF WATER RIGHTS

Southern California

One of the most important examples of a transfer of water rights is the agreement reached in 1988 between the Metropolitan Water District of Southern California (MWD) and the Imperial Irrigation District (IID), under which IID will transfer to MWD 100,000 acre-feet each year of its rights to Colorado River water, in return for which MWD will finance conservation measures for IID which are expected to conserve an equal amount of water each year. (An acre-foot is approximately 4,000 square meters covered with water to a depth of slightly more than 30 centimeters.)

Obtaining water through water transfers was apparently the most cost-effective way for MWD to make up for a decline in its allocation of Colorado River water when the federal government's Central Arizona Project began operation in 1985. The Imperial Irrigation District, in turn, had faced complaints that the rise in water level in the Salton Sea (a closed-basin hypersaline lake managed by the IID), which was threatening nearby farmland, was due to wasteful water use in the district. The state of California, responding to the complaint under provisions of state law, found in 1984 that the district's use of water was ''unreasonable'' and that conservation measures should be implemented.

The Imperial Irrigation District, which would have had difficulty financing the necessary conservation measures, turned to MWD, which valued the water more highly, and the agreement was reached by negotiation. As a result, IID will take less water from the Colorado, but will, through the use of measures such as a more flexible system of water delivery, spill interceptor canals and tailwater recovery systems, have the same amount of water for irrigation. MWD, in turn, will be allowed to take more water from the Colorado River – water that it has in effect purchased through the financing of the IID conservation measures. In the future, the entities expect to negotiate other agreements of a similar nature.

Future transfer of water between IID and MWD will depend, in part, on an assessment of environmental effects. A portion of IID's operational spill water and tailwater sustains important wildlife habitat in the Salton Sea and adjacent wildlife refuges. Several interagency groups in California have identified this issue, the environmental effects of transfers, as one of the critical issues that needs to be addressed if transfers are to be approved and implemented on a routine basis.

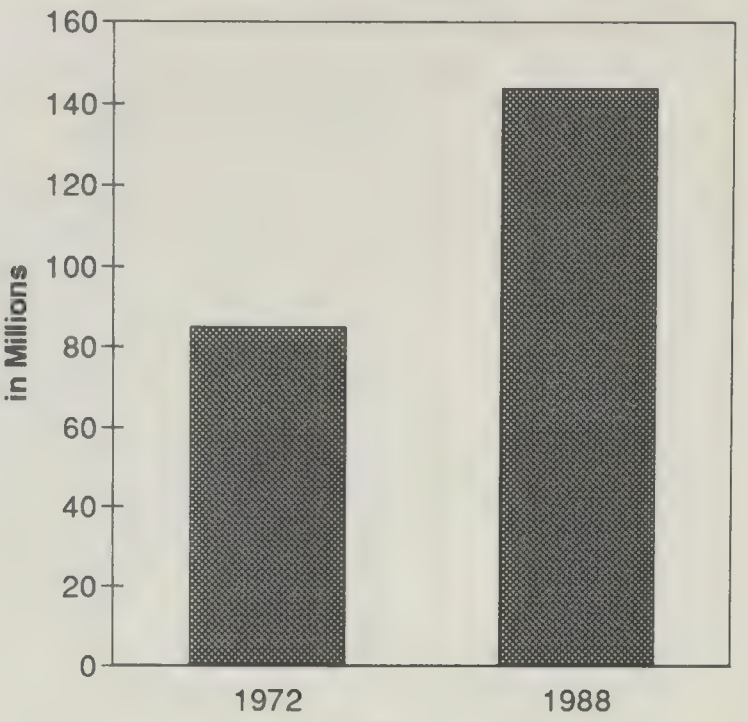
–For discussion, see Richard Wahl, *Markets for Federal Water: Subsidies, Property Rights and the Bureau of Reclamation* (Washington, D.C.: Resources for the Future, 1989), pp:142-143.–

made available to municipalities for the construction of municipal sewage treatment works, with state and local governments contributing over $20 thousand-million toward these facilities.[11] Most water pollution controls in the 1970s and 1980s were aimed at limiting discharges of the most common pollutants, such as biochemical oxygen-demanding substances, total suspended solids, oil and grease, from industrial and municipal sewage sources. These control efforts have brought some impressive results. For example:

- Between 1972 and 1988, the number of people served by sewage treatment plants having secondary treatment or better increased 69 percent—from 85 million to 144 million.[12] (See Exhibit 6c.3.)

- In the decade between 1972 and 1982, municipal loads of biochemical oxygen-demanding substances decreased by an estimated 46 percent and industrial loads decreased by at least 71 percent.[13]

- In 1988, 70 percent of the nation's rivers that were assessed by the states met their water quality standards and supported uses such as fishing and swimming.[14]



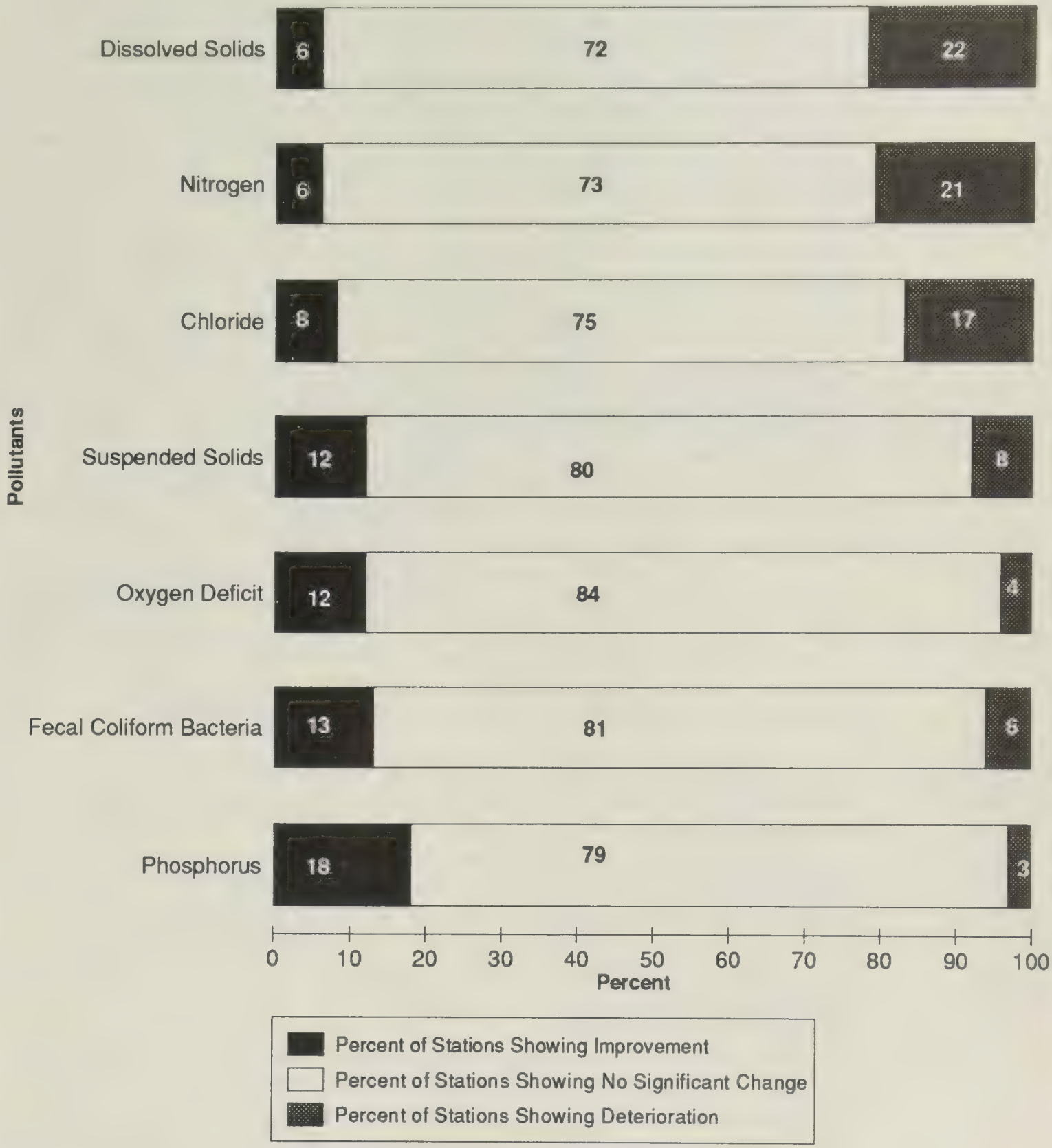
Source: 1972 statistic from U.S. EPA, Office of Policy, Planning, and Evaluation, *Environmental Progress and Challlenges: EPA's Update,* EPA-230-07-88-033, August 1988, p.49.
1988 statistic from U.S. EPA, Office of Water, Office of Municipal Pollution Control, EPA 430/09-89-001, February 1989, p.c-9.

Exhibit 6c.3

Since the mid-1970s, some pollutant levels in the nation's rivers have decreased while others have increased. In studies of water quality data from more than 300 locations on major U.S. rivers, the majority of monitoring stations showed no significant trends.[15] For stations with significant trends in dissolved oxygen, fecal bacteria and phosphorus, those showing decreases in pollutant concentrations were greater than the number showing increases. Wastewater treatment appears to be primarily responsible for improvements in the extent of bacteria and phosphorus contamination. These studies did not reveal a strong link between improved sewage treatment and dissolved oxygen improvements far downstream, indicating that the beneficial effects may be more local than regional in extent. (See Exhibit 6c.4)

The studies showed declining water quality (e.g., increasing pollutant trends) with respect to nitrogen as well as chloride and other dissolved solids. Recorded increases in nitrogen fertilizer application and use of salt on highways appear to be contributing to these problems. Nitrogen increases at monitoring stations from 1974 to 1981 also were strongly associated with high levels of atmospheric nitrate deposition, particularly in the Ohio, the Mid-Atlantic, the Great Lakes and the Upper Mississippi basins. Trends in suspended solids and sediment show neither strong improvement nor deterioration. It is important to note that only limited data are available in the United States for scientifically defensible national water quality trends assessment. The U.S. government is currently exploring ways to improve reporting on water quality indicators.

Trends in Selected Pollutants in U.S. Rivers, 1978-1987



Source: Dennis P. Lettenmaier, Eric R. Hooper, Colin Wagoner, and Kathleen B. Faris, "Trends in Stream Quality in the Continental United States, 1978-1987," *Water Resources Research,* March 1991, Vol. 27, No. 3, pp. 327-339

Exhibit 6c.4

Regulation of Surface Water Quality

Under the 1972 Clean Water Act, states adopt and the federal government approves water quality standards, which include a "designated use" such as fishing or swimming, and criteria that define how the designated use is to be achieved. To achieve these standards, the federal government or states that have a federally approved program issue permits to discharge effluent from a specific source into the nation's waters; currently 38 states and one territory are authorized to operate these permit programs. These National Pollutant Discharge Elimination System (NPDES) permits specify limits on the discharge of pollutants. The permit limits may be based on either technology or water quality. Technology-based limits are derived from government-issued national effluent guidelines for given categories of industries and sewage treatment plants, and generally reflect the application of the best available control technology that is economically achievable. These standards generally reduce pollutant loadings by 90 percent.[16] For sewage treatment plants, the limits are based on secondary-treatment technology (85-percent removal of conventional pollutants such as oxygen-demanding materials and suspended solids). Where technology-based permits are not adequate to achieve water quality standards for a particular water body, additional permit limits based on water quality may needed to be placed on a plant's discharge. Federal and state governments have issued permits to approximately 48,000 industrial and 15,000 municipal facilities. NPDES permit requirements are backed up by federal and state compliance and enforcement activities. Approximately 30,000 industrial facilities that discharge to municipal sewage treatment plants, rather than discharging directly into surface waters, are also covered by technology-based requirements.

In 1987, Congress passed the Water Quality Act, which reauthorized and strengthened the Clean Water Act. This new act phases out continued federal support for municipal sewage treatment plants in favor of seed money for self-sustaining state revolving funds, initiates a new state-federal program to control non-point source pollution, strengthens enforcement authorities and accelerates the imposition of tighter controls on toxic pollutants.

Issues in Surface Water Quality

Despite these state and federal efforts, poorly treated sewage continues to cause pollution problems in some areas of the United States, particularly in coastal areas and small communities. Some cities and towns are still on construction schedules to reach secondary treatment levels. The quality of sewage treatment plants has increased dramatically over the last 20 years, but so has the number of people served by these systems. The resulting increases in flow have placed continued stress on many of the nation's water bodies. During rainstorms, overflow into surface waters from municipal sewer systems that are interconnected to storm sewers also remains a problem in approximately 1,050 cities.

Another complex and persistent problem that has come under more scrutiny in recent years is non-point source pollution, which is now responsible for over half of the impairment to the nation's rivers, streams and lakes.[17] Nutrients, sediments, toxics and other pollutants often come from small, widely dispersed land sources that can be difficult to identify and control. These sources include runoff of silt, animal wastes, fertilizers and pesticides from agricultural activities, runoff from mining operations and urban runoff. (See Exhibit 6c.5.) These sources are subject to differing degrees of regulation at the federal, state and local levels by various statutes, including the Clean Water Act. The act gives states the lead responsibility for developing non-point source control programs, which may use a range of regulatory and nonregulatory elements at the discretion of the state. Over the last two years, the U.S. government has awarded nearly $90 million in grants to states to stem the flow of pollutants from non-point sources.

Toxic water pollutants have also become a major concern. With over 60,000 chemicals in use in the United States, efforts to control toxics are difficult. Both the technical capability to detect these pollutants and our knowledge of their impacts on the environment have increased in recent years and have made it possible to uncover a wide variety of effects, often related to minute levels of toxic discharges. Toxic pollutants can persist in the environment for many years, and through the process of bioaccumulation can adversely affect fish, other wildlife and humans. Contaminated bottom sediments also present a potential risk, especially in industrialized or urbanized areas. Toxic pollutants come from indirect industrial discharges to sewage treatment plants, direct discharges to surface waters, runoff contaminated with heavy metals and pesticides, and atmospheric deposition from local sources (such as automobiles) and more distant sources.

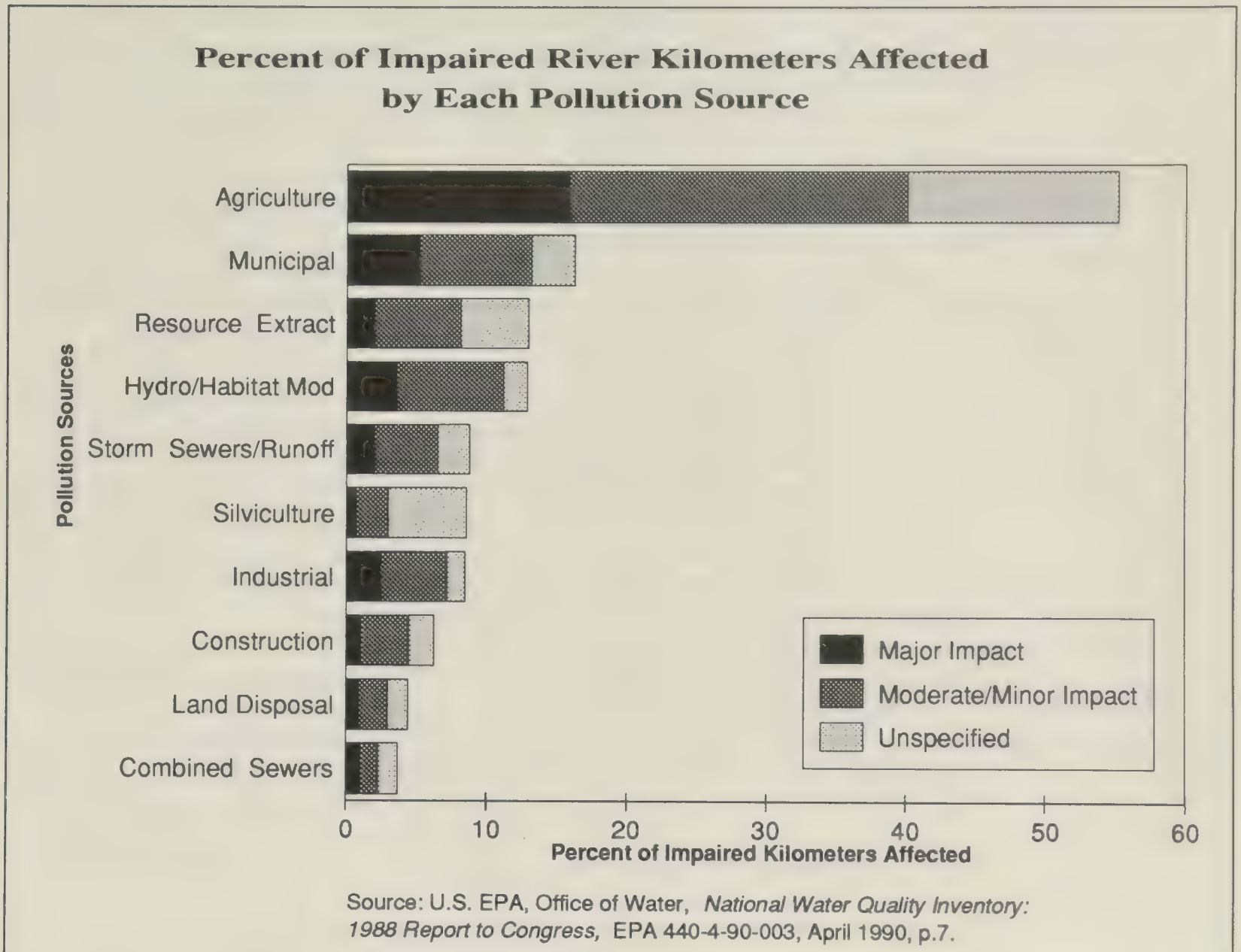


Exhibit 6c.5

Loss of aquatic biodiversity is also an increasing concern. Since 1900, 30 of the 2,000 species of fish in the United States are known to have become extinct. Since 1970, 10 species have become extinct in spite of significant management efforts to save them. The Great Lakes and Great Basin regions of the United States have lost the greatest number of fish species. In most cases, more than one factor contributed to these declines. The most common cause of extinction in North America is habitat loss, which contributed to the loss of at least 73 percent of the species. The other causes, in decreasing

order, were introduced species (68 percent), chemical alterations or pollution (38 percent), hybridization (38 percent) and over-harvesting (15 percent).[18]

At this time 87 fish species are formally listed as threatened or endangered under the authority of the Endangered Species Act.[19] As of 1989, the American Fisheries Society listed 364 fish species in North America that warrant protection because of their rarity, of which 254 are located in the United States. While most states in the United States have fish species on the list, the largest number are in the Southwest and Southeast. Local recovery efforts have been effective for some species, but recovery rates lag behind deterioration rates. Despite ongoing protection efforts, no fish species has been removed from the American Fisheries Society list in the last 10 years because of successful recoveries; while seven species have improved in status (but remain on the list), 22 have declined, and 10 have become extinct.[20]

Focusing conservation efforts on entire ecosystems rather than on individual species is more likely to provide permanent protection than are isolated recovery efforts. Habitat destruction is caused by a number of human activities. Development projects such as dams, highway construction, and dredge and fill activities along the nation's waterways can have significant impacts by modifying fish habitat, and often result in conditions that favor more common lake and pond species at the expense of less abundant river and stream species. Dams interfere with the migration of anadromous fish to upstream spawning areas and the downstream migration of young fish to the sea. Although specially created fishways or fish "ladders" can provide access to spawning grounds for some species, it is more difficult to develop fish passage facilities to protect newly hatched fish. Juvenile fish may be adversely affected as they pass through hydroelectric turbines when migrating downstream. In addition, highway construction, residential and industrial development, and agricultural activities can generate silt and sediment that suffocate developing fish eggs, and eliminate or degrade rearing and spawning habitat. Acid deposition has also been shown to be a significant factor in fish habitat destruction in some areas. In the arid West, reduced instream flows, resulting from diversions for irrigation and municipal and industrial purposes, have contributed to the decline fish populations.

Innovative approaches are needed to address many of these problems. The uniform national regulatory approaches of the past are unlikely to be sufficient in the future for solving the diverse and complex problems facing the nation's water resources. The challenge is to use innovative tools and approaches that supplement national regulatory actions by addressing specific water quality and quantity problems within a given watershed. The federal government will rely even more strongly on state and local governments and citizen involvement to achieve the nation's water quality goals in the future.

Comprehensive Approaches. Several innovative approaches are achieving results and hold considerable promise for the future: pollution prevention, ecosystem or watershed-wide approaches and geographic targeting.

Pollution prevention techniques avoid or minimize pollution before it is generated. Not only does prevention avoid cross-media transfer of pollution and residuals generated by treatment processes, but it also can be a more cost-effective solution to many pollution problems. According to the National Association of Manufacturers, one U.S. chemical firm has eliminated 10,000 tons of water pollutants, 150,000 tons of sludge, and 5.7 million liters of wastewater annually since 1975. The firm achieved these reductions at a savings of $435 million through product reformulation, process modifications, equipment redesign and recovery of waste materials. The federal government

is encouraging voluntary prevention activities by industry, state and local government, and private individuals. This approach is intended to achieve more than traditional regulatory, end-of-the-pipe approaches alone, particularly for non-point source pollution and persistent bioaccumulative toxics, which are often discharged in minute quantities but still cause serious problems in the long term.

Watershed-wide ecosystem approaches to water resources management are more comprehensive, going beyond individual chemical parameters or individual species protection efforts; they recognize the often less understood complex interactions of individual processes. (For example, see the case study on the Great Lakes.) This is a particularly challenging area for the future.

Geographic targeting allows agencies to develop and tailor solutions that are most appropriate for particular water quality problems at the local level. National approaches provide an important baseline of protection, but often additional site-specific measures can target additional program efforts to solve problems that are more serious at the local level than they are nationally, that require more resources than can be sustained nationally or that call for different solutions.

Technical Tools. To date, the focus of surface water quality programs has been on the chemical parameters of the nation's water bodies, with relatively less attention placed on the biological and physical (i.e., habitat) characteristics. The critical loss and alteration of habitat and the loss of biological diversity are now receiving increased attention in the surface water program. The federal and some state governments are developing biological and physical criteria and standards to assess and protect ecosystem health.

Funding Tools. Funding responsibilities for municipal wastewater treatment plants have already begun to shift from the federal government to the states. In 1988, the United States estimated that an additional $83.5 thousand-million is needed for these facilities.[21]

To help pay for them, Congress authorized "seed" money for states to establish "revolving loan" programs to replace federally-financed construction grants. These state revolving-loan programs are designed to finance projects at the local level through loans that are repaid into the fund. Even with this assistance, small communities have limited means to finance needed facilities. All 50 states now have established these revolving-fund programs, and the federal government is helping states to find alternative funding mechanisms, such as fees-for-service, to pay for needed expansion of state and local water programs.

CASE STUDY:

COMPREHENSIVE PROTECTION EFFORTS

THE GREAT LAKES ECOSYSTEM

Canada and the United States share a unique aquatic ecosystem containing the world's largest area of freshwater outside the polar ice caps. Described as sweetwater seas by early European explorers, the Great Lakes comprise 20 percent of the world's fresh water supply. Thirty million people live within the drainage basin, which covers 767,500 square kilometers. The lakes have had a significant role in the development of both the United States and Canada: they are sources of drinking water for millions; an essential resource for industrial processes; an avenue for national and international shipping; valuable fisheries for subsistence, commercial and sport fishing; a rich and diverse biological community; and an invaluable recreational and aesthetic resource.

However, the legacy of industrial development in the Great Lakes region has been one of immense environmental changes. By the 20th century, huge tracts of forest had been cleared, overfishing had devastated natural fisheries, and water-borne diseases such as typhoid and cholera had become major causes of death in lakeside human communities. The destruction of this natural ecosystem continued with the devastation of the natural Great Lakes fishery by the sea lamprey, nutrient overloading from human and agricultural wastes, and loadings of toxic pollutants such as mercury and petroleum products. By the mid-1960s Lake Erie was considered dead, as a consequence of eutrophication; the Cuyahoga River caught fire from heavy pollution by oil and flammable wastes; DDT and other pesticides were decimating wildlife populations; and wetlands that had originally covered one-fifth of the Great Lakes Basin had been reduced to about half of their original extent.

Significant progress has been made during the last twenty years in restoring the ecological integrity of the Great Lakes. A massive public works campaign to construct municipal sewage treatment facilities has reduced pollutant loadings throughout the Great Lakes Basin. Fires no longer occur on Great Lakes waterways. Populations of predatory birds can once again be found throughout the Basin. However, significant problems still remain including continued loss of habitat, the introduction of nonresident species and the presence of persistent bioaccumulative toxic chemicals. Airborne pollutants, often transported over long distances, have been identified as one of the most significant sources of toxic pollutants. Contaminated sediments are also a major source of toxic pollutants. Coping with these problems requires a new model, one of multimedia, multiparty coordination.

The Great Lakes Water Quality Agreement, signed by the United States and Canada in 1972 and amended in 1978 and 1987, is a comprehensive accord that addresses the need for coordinated, long-term environmental protection by both countries. Activities to implement this new, integrated approach to the restoration and protection of the Great Lakes can be seen at all levels of government, including federal, provincial, state and local.

Cleanup of the most impaired areas in the Great Lakes Basin, formally designated Areas of Concern, will be achieved through the development and implementation of Remedial Action Plans. Lakewide management plans to control critical pollutants are being developed for each of the Great Lakes. Implementation of these plans will be a long-term effort, focusing on priority problems with lakewide impacts.

Coordinated strategies to protect and restore existing natural habitats, as well as to increase the overall size of such habitat, are being developed. In conjunction with these efforts, programs designed to achieve a suitable and stable mix of wildlife populations, such as the North American Waterfowl Management Plan, are underway. Research into the control and elimination of damaging exotic species, such as the zebra mussel, is ongoing. Agencies in both countries are developing new strategies and improving existing ones to control the spread of all nuisance species.

Federal, state and local agencies are undertaking coordinated enforcement efforts to ensure that all the pollution problems in a geographic area are considered together. Voluntary pollution prevention agreements are being reached with a variety of industries to decrease pollutant loadings in the Great Lakes Basin. In addition, local, grassroots efforts are being fostered to reduce pollution emissions at the individual household level.

Exhibit 6c.6

Groundwater Quality

The protection of groundwater quality is an exceptionally complex issue, cutting across all levels of government and many environmental statutes. The nation's groundwater is a vitally important natural resource—as a source of drinking water for approximately half of the U.S. population, as a support system for sensitive ecosystems, and as a water supply source for industry and agriculture. Once contaminated, it can be enormously expensive and technically difficult or impossible to clean up.

For generations, land surface and subsurface disposal of wastes was considered safe and convenient. More recently, researchers have come to understand better that natural processes have only limited capacity to change contaminants into harmless substances before they reach groundwater. Contaminants found in groundwater include organic and inorganic chemicals, radionuclides and microorganisms.

A recent nationwide survey documented low-level contamination of drinking-water wells by nitrates, although only a small portion of the wells—from one to two percent—is considered to be contaminated by nitrates at levels of potential hazard to human health. The same survey found that less than one percent of drinking-water wells had pesticide residues above human health concern levels.[22] Although this proportion is small, there are numerous specific incidents of contamination which have had significant health and economic impacts on individuals or communities where groundwater is used for drinking water.

There are many uncertainties about the human health impacts of contaminated groundwater because empirical data on the nature and extent of

groundwater contamination are limited and because the impacts are often difficult to study. However, some contaminants found in groundwater have been linked to cancer, liver and kidney diseases, and damage to the central nervous system. Vegetation, fish and wildlife also can be adversely affected by contaminated groundwater. Because groundwater provides about 40 percent of the average annual streamflow in the United States, the potential for adverse impacts on surface water quality may be large, especially during periods when dilution by surface water is minimal.[23]

Groundwater Protection Programs

Since issuing a Groundwater Protection Strategy in 1984, the United States has provided $57 million in technical and financial assistance to the states to build their capacity to protect groundwater. The federal government is also engaged in developing and implementing groundwater pollution prevention efforts; regulating the availability and use of pesticides and helping users to apply them in ways that minimize the risks of contamination; regulating hazardous waste facilities, municipal landfills, surface impoundments and underground storage tanks; and cleaning up past and current releases of hazardous substances.

In addition to these federal activities, states have made progress in developing and implementing comprehensive groundwater protection strategies and programs; some states have implemented wellhead protection programs to protect community water supplies taken from groundwater sources. Wellhead protection programs establish how states and local governments designate and protect the area around public drinking water wells from contamination. Potential contamination sources may include the ones mentioned above, which are subject to federal requirements, as well as many local sources such as septic tanks, highway de-icing salts and accidental chemical spills. As a result of the highly site-specific nature of potential well contamination, local siting restrictions and land use planning requirements are very effective tools for wellhead protection. By mid-1991, the U.S. government had approved 16 state wellhead protection programs and was working with 22 other state programs in the approval process.

Future Directions in Groundwater Quality

Despite progress in protecting groundwater in recent years, gaps remain. In 1989, the U.S. government established a Groundwater Task Force to make recommendations to address these gaps. The Task Force recently released a report that sets forth a new strategy provide comprehensive protection to the groundwater resources of the United States and to guide the course of federal and state efforts over the coming years.[24] Because of the existence of numerous and diffuse sources of contamination and the site-specificity of groundwater characteristics, climate and land-use practices, the new policy continues to call for the states to have the primary responsibility for protecting groundwater. The policy is intended to lead to coordinated state actions to protect groundwater from all contamination sources.

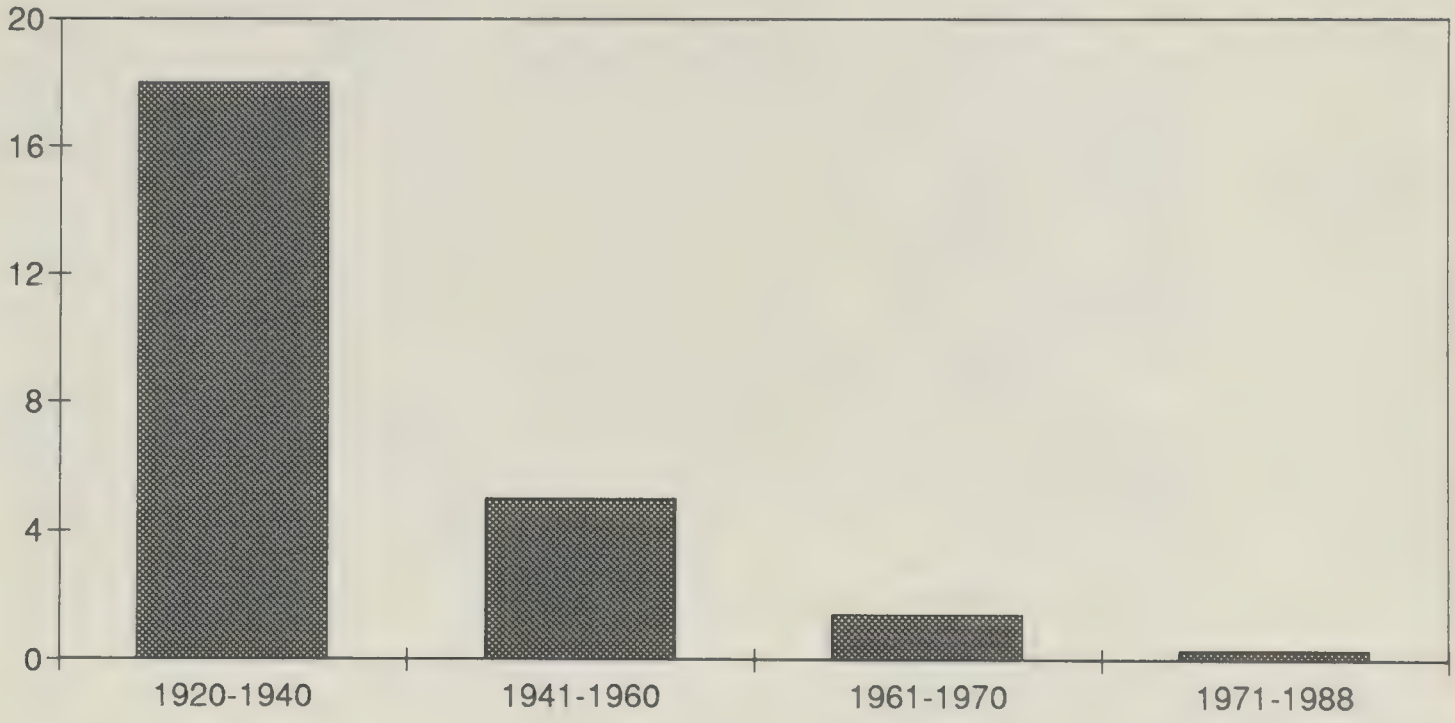
Given the technical difficulties and expense of cleaning up groundwater contamination, the U.S. strategy emphasizes preventing contamination from occurring in the first place. In addition to the emphasis on prevention, the new policy charts a "resource protection" approach, whereby states are to develop protection programs that take into account potential sources of contamination as well as the unique hydrogeologic features of their groundwater resources. These programs would coordinate all federal and state groundwater protection actions and build the foundation for setting and addressing priorities across all sources and between prevention and remediation activities. The federal government will continue to provide financial and technical assistance to help states fill the gaps in their groundwater protection programs, and will encourage states to submit these

programs to the federal government for its concurrence that they are adequate to protect the resource.

Drinking Water Quality

The United States has made vast improvements in the quality of its drinking water supplies since protection efforts began nearly a century ago. In the late 1800s, over 400 people died and tens of thousands grew ill every year from acute waterborne disease outbreaks in the United States.[25] By the early 1900s, however, waterborne typhoid fever and cholera were nearly eliminated in the United States through the application of filtration and disinfection by water supply systems.[26] (See Exhibit 6c.7.) Data available since the early 1900s indicated that this trend has continued; only one cholera outbreak has been reported since 1920. Typhoid fever accounted for 70 percent of reported waterborne disease outbreaks between 1920 and 1940, while it accounted for less than one percent between 1971 and 1988.[27] Currently, the World Health Organization regards U.S. drinking waters as among the best protected in the world.[28]

Number of Waterborne Outbreaks Due to Typhoid Fever (per year)



Source: Gunther F. Craun, "Causes of Waterborne Outbreaks in the United States," *Water Science and Technology,* Vol. 24, No. 2, pp. 17-20, 1991.

Exhibit 6c.7

The U.S. drinking water protection strategy focuses on two types of contamination—microbiological and chemical. While most of America's drinking waters are remarkably free of microbiological contaminants, the problem is not fully solved. Based on voluntary reporting of information, there were still an average of 31 reported waterborne disease outbreaks per year between 1971 and 1988, affecting an average of nearly 7,700 people per year with most outbreaks occurring in small water systems. However, the

voluntary nature of reporting outbreak information makes trends difficult to determine. Outbreaks of unknown origin account for one-half of reported waterborne disease outbreaks, while Giardia (a protozoan that is now ubiquitous in surface water supplies) accounts for 18 percent of reported outbreaks between 1971 and 1988.[29] The United States has recently finalized a surface water filtration rule that, when fully implemented, should virtually prevent future waterborne disease outbreaks.

Chemical threats in drinking water constitute a second category of potential risk, which was largely neglected until 20 years ago. Analytical chemistry advances have made possible the detection of increasingly lower concentrations of chemicals in drinking water. The current and continuing challenge is to fully understand the health effects of these low levels of chemical contaminants, to set appropriate standards to protect human health and to evaluate treatment processes to achieve these standards.

In 1974, the Safe Drinking Water Act (SDWA) authorized the federal government to establish regulations to limit the amount of various substances in water used for drinking. The SDWA established the states as the primary level of government responsible for implementing and enforcing drinking water regulations and monitoring the operation of all public water systems, and assigned the federal government responsibility as overseeing the states. At present there are approximately 200,000 public water systems regulated under the SDWA and serving the vast majority of the population.[30] There are, however, approximately 12.3 million private wells, located primarily in rural areas, that are not subject to SDWA requirements.[31]

As of 1986, the United States set federal standards for 23 drinking water contaminants. In 1986, amendments to SDWA accelerated the regulation of contaminants, requiring development of regulations for 83 specific contaminants by 1989 and 25 additional contaminants every three years thereafter. The amendments required filtration treatment for virtually all surface water sources and disinfection for groundwater sources in most cases. The amendments also banned all future use of lead pipe and lead solder in public drinking water systems, mandated greater protection of groundwater sources of drinking water, and streamlined procedures to ensure that public water suppliers comply with the act.

SDWA also established provisions to protect groundwater supplies from underground injection of wastes. These controls regulate the permitting, construction, operation, monitoring and closure of five classes of injection wells. Also under authority of SDWA, the wellhead protection program discussed above was created. In addition, SDWA requires public water supplies to monitor their water for specific unregulated contaminants.

Issues in Drinking Water Quality

The federal government is seeking further improvements in its program to ensure that all citizens are afforded the benefits of safe drinking water. While community water systems have an overall rate of compliance with existing standards of approximately 73 percent, the compliance rate of small systems remains a significant concern. Small systems (those serving 25 to 3,300 people) were responsible for over 90 percent of the community water system violations in 1990, including violations of drinking water standards as well as monitoring and reporting violations.[32] Small systems often have comparatively limited financial and technical resources to address these problems and meet the complex requirements of the SDWA.

Pursuant to legal requirements in the 1986 SDWA amendments, the United States expects to set new standards for 111 contaminants by the end

of 1995 and will work with the states to enforce them. (See Exhibit 6c.8.) These new or revised standards, while ensuring good quality drinking water, can be very expensive, particularly for small communities. The costs for making all the water system improvements necessary to comply with the SDWA is estimated at an annualized cost of over $3 thousand-million per year over the next 20 years, including capital costs and annual operating costs.[33] States will need an estimated additional $200 million to develop and install new programs, and $131 million annually to oversee and enforce compliance with the new regulations.[34]

To alleviate this financial burden, the federal government is exploring new and more affordable technologies, and is helping states to certify and train small water plant operators. The government is also encouraging adoption of management practices that save money, such as regional combinations of small systems into larger, more cost-effective operations. In addition, some communities may be able to reduce costs of monitoring and treating water used for drinking through the implementation of aggressive wellhead protection programs.

DRINKING WATER CONTAMINANTS

REGULATED PRIOR TO 1974		TO BE REGULATED BY 1995	
Inorganics	10	Inorganics	17
		Organics	28
Pesticides	6	Pesticides	27
Microbiologicals	1	Microbiologicals	5
Radionuclides	4	Radionuclides	6
		Disinfectants and disinfection byproducts	2
Other	1	Other	1
		To be selected	25
Total	**22**	**Total**	**111**

Exhibit 6c.8

Wetlands

Considered among the most biologically productive of all ecosystems, wetlands provide essential breeding, spawning, nursery, nesting, migratory and/or wintering habitat for a large portion of the nation's migratory and resident fish and wildlife. Hydrologic functions of wetlands include surface and groundwater recharge and discharge, water quality enhancement, flood water conveyance and storage, and shoreline and erosion protection. Wetlands also support a wide variety of recreational uses, including boating, sport fishing, hunting, bird watching and nature observation.

U.S. wetlands range from the Gulf of Mexico coastal salt marshes to the permafrost-underlain wetlands in Alaska. They include delta swamp and boglands in Mississippi and Louisiana; the Florida Everglades; tropical rainforests in Hawaii; "prairie potholes" in North and South Dakotas, Montana, Nebraska, Iowa and Minnesota; and riparian wetlands in the arid Southwest.

The nation's remaining wetlands comprise five percent of the surface area of the United States. These wetlands provide food and shelter for more than one-third of our endangered species and approximately one-third of all of American's bird species.[35] Eighty percent of the country's breeding bird population requires bottomland hardwood wetlands for survival. Wetlands also provide important corridors for animal movement along rivers, streams and lakes. Even some species not generally thought to be reliant on wetlands, such as the black bear and Florida panther, are, in fact, severely affected by wetlands loss. In some areas, wetlands are the last remaining undeveloped places to provide corridors that link larger patches of natural habitat.[36]

Wetlands can also improve water quality by removing sediments, nutrients, and other pollutants before they reach other waters. Sediment removal rates of 80-90 percent are common in floodplain wetlands, and wetlands have been shown to remove as much as 70 percent of phosphorus and 70 to 90 percent of nitrogen in adjacent river waters.[37] The flood control and erosion control benefits of wetlands have also been well documented. For example, instead of building expensive dams or levees in the Charles River basin in Massachusetts, the federal government decided to preserve about 3,400 hectares of wetlands, which—as overflow areas during flooding are estimated to save approximately $17 million annually in flood damages.[38] Studies in the Midwest have demonstrated 80-percent reductions in flood flows in river basins with wetlands compared to those without wetlands.

Wetlands are subject to both natural and manmade stresses, which affect their abundance as well as the quality of the habitat and functions they provide. Natural events, such as erosion, fire, sea-level rise, beaver and muskrat activity, and natural succession can alter wetland conditions and functions. Most of the U.S. wetland losses that have occurred since European settlement, however, are attributed to drainage and other human activities such as agriculture; commercial and residential development and supporting infrastructure; flood control and highway projects; oil and gas exploration and production; mining of coal, minerals and peat; and stream diversions and impoundments.

Wetland Losses

The value of wetlands and their overall environmental importance have only recently been recognized. For most of U.S. history, wetlands were viewed as a hindrance to productive land use. Swamplands, bogs, sloughs and other wetland areas were considered wastelands to be drained, filled or manipulated to produce commercial, rather than natural, services or commodities. The Swamp Land Acts of 1849, 1850 and 1866 provide an early example; these acts gave federal lands in certain states to private parties on the condition that they be drained.

Since the 1700s, more than half of America's wetlands have been drained, dredged, or otherwise modified to provide what was thought to be more valuable lands and uses. It has been estimated that the land area that now comprises the United States originally contained almost 157 million hectares of wetlands (89 million hectares in the conterminous 48 states). (See Exhibit 6c.9.) By the 1980s, an estimated 41 million hectares of wetlands remained in the conterminous United States. Areas with the largest wetland loss are the prairie pothole region, and the lower Mississippi River Valley delta. By contrast with the lower 48 states, most of Alaska's wetlands are still intact. Since the 1700s, Alaska has lost only a fraction of a percent of its original 68 million hectares of wetlands.[39]

A recent assessment of wetlands status and trends indicates that, over a nine-year period encompassing 1974 to 1983, the net area of wetlands declined by one million hectares, for an approximate average loss of 116,000 wetland hectares per year.[40] A more recent study of wetland losses on rural,

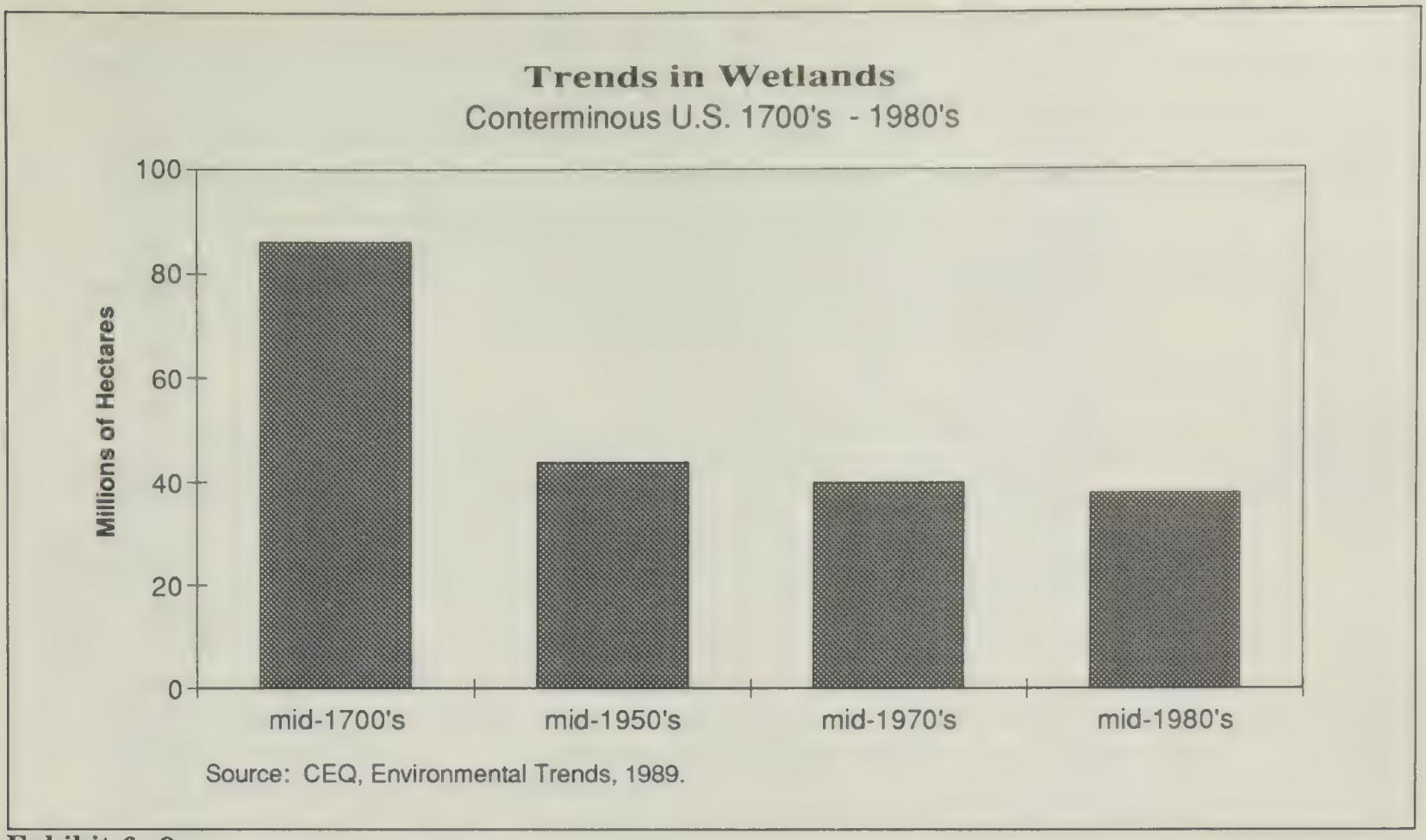


Exhibit 6c.9

a nine-year period encompassing 1974 to 1983, the net area of wetlands declined by one million hectares, for an approximate average loss of 116,000 wetland hectares per year.[40] A more recent study of wetland losses on rural, private lands between 1982 and 1991, indicates that conversions from wetlands to farmlands or other use have declined significantly in the Farm Belt.

Agricultural activities were responsible for 87 percent of the national wetland losses from the 1950s to the 1970s, when wetlands were being lost at an annual rate of approximately 183,000 hectares per year.[41] By the 1980s, the portion of wetland losses attributable to agriculture had dropped to 54 percent.

In addition to loss of wetland surface area, the United States is increasingly concerned about degradation of the functional integrity or health of the remaining wetlands. The capacity of wetlands to preform pollution removal and other environmental processes is threatened by physical and hydrological disturbances. At present, data are only available from several states on the pollutants and pollutant sources affecting the integrity of wetlands and, therefore, do not represent a national picture. However, the leading problems in these states appear to be metals, siltation, salinity, flow alteration, nutrients, pesticides and organic enrichment contributed by agriculture, habitat modification, resource extraction and other sources.[42]

Government agencies are pursuing various approaches to wetlands protection, including acquisition, economic incentives and regulations. The major federal regulatory tool is Section 404 of the Clean Water Act, which establishes a permit program to regulate the discharge of dredged or fill material into waters of the United States including most wetlands. The program is jointly administered by the U.S. Army Corps of Engineers and the Environmental Protection Agency. The U.S. Fish and Wildlife Service and the National Marine Fisheries Service have important advisory roles in reviewing permit applications.

Several wetland conservation programs have recently been

removed from agricultural production and another 400,000 wetland hectares have been scheduled for restoration. The Food Security Act's "Swampbuster" program denies federal farm program benefits for converting wetlands to cropland. Through the North American Waterfowl Management Plan, the United States is working cooperatively with Canada and Mexico to protect 2.4 million wetland hectares that are prime waterfowl habitat. Many state legislatures have enacted wetland acquisition or protection statutes that complement federal programs. In addition, public education and technical assistance have helped heighten public awareness of the economic and environmental values of wetlands.

Issues in Wetlands Protection

Americans are recognizing the value of wetlands and are taking steps to conserve them. The United States is striving to achieve a balance between conserving, mitigating, creating and restoring valuable wetland ecosystems and accommodating appropriate agricultural and development activities. Two of the most challenging issues in wetlands protection have been how to define a wetland and how to determine what type of protection is appropriate for areas so defined. The current debate over what exactly constitutes a wetland for regulatory purposes is rooted in concerns about the balance between the need for agriculture, economic development and protection of our valuable wetland resources, and the extent to which national policy should restrict activities on private lands. The resolution of this issue requires the involvement of all affected interests.

On August 9, 1991, the U.S. government announced a comprehensive plan for improving the protection of the nation's wetlands. The plan is based on the view that Americans must look beyond regulation to encourage wetlands protection. The plan acknowledges that enhanced public understanding of the value of wetlands is necessary for wetlands protection. The plan also notes the importance of private, state and local actions to conserve wetlands. Key elements of the wetlands plan are as follows:

- Wetlands acquisition and other non-regulatory programs to protect wetlands will be strengthened. These programs include wetland restoration and creation efforts, inventory and mapping, research and education.

- The current wetlands regulatory system will be improved and streamlined in order to ensure that wetlands protection policies are pursued in balance with policies that promote other valid human needs.

Truly effective programs to protect our nation's wetlands require the cooperation of federal, state and local agencies, developers, environmental groups, the scientific community and others. Active citizen support and participation is an essential ingredient of such a program.

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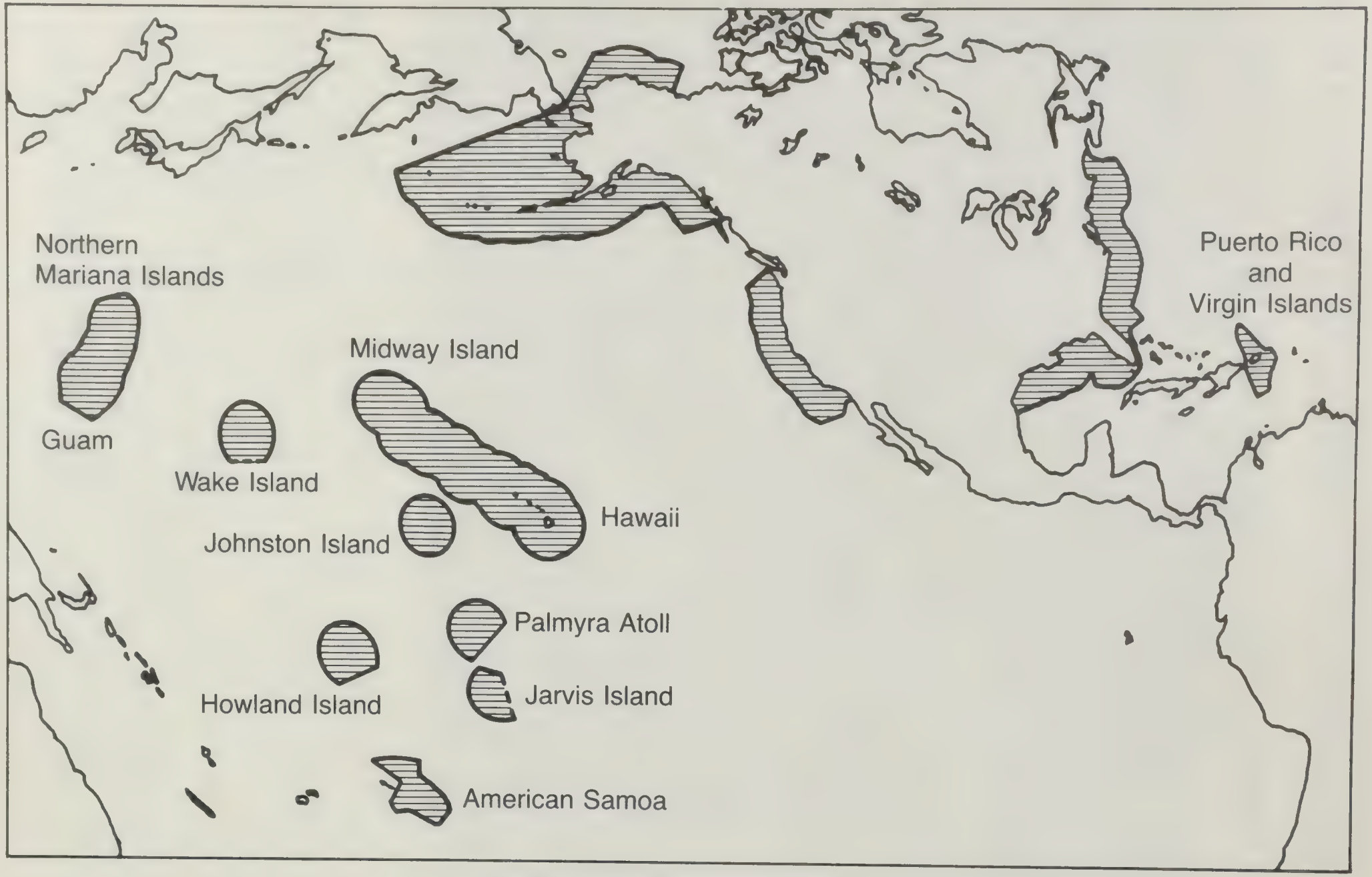
Oceans and Coastal Resources



The Exclusive Economic Zone

(Baker Island, Kingman Reef and Navassa Island are not shown.)

By proclamation of the President on March 10, 1983, the United States claimed sovereign rights and jurisdiction within an Exclusive Economic Zone (EEZ). The United States is responsible for wisely developing, managing and protecting the EEZ's environment and marine resources within an area of over three million square nautical miles.

Exhibit 6d.1

Overview

The states and insular areas of the United States have a total of over 20,000 kilometers of coastline. The United States exercises sovereignty over the estuarine and near-coastal waters of its adjacent territorial seas. In accordance with international law, the United States also exercises rights and responsibilities for resource conservation and management and environmental protection in its Exclusive Economic Zone (EEZ).[1] Coastal and ocean ecosystems often extend beyond U.S. maritime zones into areas where similar rights and responsibilities are exercised by Canada, the former Soviet Union, Mexico and several nations of the Caribbean and Pacific. Exhibit 6d.2 summarizes selected ocean and coastal resource facts.

The Exclusive Economic Zone of the United States, an area of 3.36 million square nautical miles (1.14 thousand-million hectares), contains approximately one-fifth of the world's harvestable fish and shellfish. Exhibit 6d.1 illustrates the extent of the U.S. EEZ. In 1990 commercial landings by U.S. fishing vessels were valued at $3.9 thousand-million dollars. The value-added contribution of commercial marine fishery products added approximately $16.6 thousand-million to the U.S. gross national product. Consumers spent $26.6 thousand-million on seafood products.[2] A substantial portion of oceanborne trade occurs in territorial waters and the EEZ.

Coastal and estuarine areas include some of the richest, most diverse and most productive ecosystems on Earth. Important coastal habitats include: estuaries, salt and fresh marshes, tidal flats, coastal wetlands, sandy beaches, barrier islands, seagrass beds, mangrove forests, coral reef ecosystems, and deltas and dunes. It is difficult to quantify the economic benefits of some of these habitats and ecosystems. However, coastal waters sustain complex food webs that support important spawning, nursery and feeding grounds for commercially, recreationally and ecologically important fish and shellfish species.[3] Almost 70 percent of commecially and recreationally important species of fish and shellfish rely on estuaries for part of their life cycle.

At least 30 percent of North American waterfowl winter in estuarine areas. Many other migratory birds depend on coastal or estuarine areas for breeding or migration. Shallow water estuaries and wetland areas provide important refuges or "staging points" for migratory birds during their annual flight patterns. A number of marine mammals and endangered species spend part or all of their lives in coastal areas and specially protected areas of the United States. Coastal wetland vegetation filters pollutants, retains sediments, buffers coastal lands against erosion and flooding, and maintains integrity of groundwater quality and supply. However, these coastal areas and habitats are susceptible to degradation from human activities as well as natural events.

Coastal areas are highly desired locations for people seeking either permanent or "second home" residences. In 1990, approximately 110 million people in the United States (40 percent of the total population) lived within 80 kilometers of a coastline. By 2010, the population of the United States' coastal counties is expected to rise to 127 million people. The nation's most densely populated coastal region stretches along the U.S. northeast coast from Boston, Massachusetts, to Washington, D.C., and accounts for one-third of the nation's coastal population. The Southeast's coastal population is expected to increase 200 percent by 2010 with development of "retirement-oriented" communities.[4] In addition to the 50 states, over 3.6 million citizens and U.S. nationals live in eight inhabited insular areas that are under U.S. sovereignty in the Pacific and Atlantic oceans. The population is also increasing rapidly in these areas. (See Exhibit 1.5 in Chapter 1.)

SELECTED OCEAN AND COASTAL DATA

COASTAL LAND AND WATER AREA

Exclusive Economic Zone (EEZ) area:
Total EEZ: 3.36 million square nautical miles (1.14 thousand-million hectares)

Estuarine Drainage Area:
676,000 square kilometers

Coastal Wetlands:
84,000 square kilometers (11 million hectares), approximately 12 percent of total estuarine drainage area

	Coastline *(statute miles)*	**Exclusive Economic Zone** *(square nautical miles)*
Conterminous only:	**4,993**	
Atlantic	2,069	253,800
Gulf	1,631	186,200
Pacific*	1,293	236,800
Alaska (total)	6,640	950,000
Hawaii	750	695,000
Extra-territorial:		
Caribbean**	441	58,400
Pacific***	335	981,000
Total:	**13,056**	**3,362,600**

* excluding Hawaii, Alaska, American Samoa and Guam, and other U.S. insular areas
** including Puerto Rico and the U.S. Virgin Islands
*** including only American Samoa, Guam and the Commonwealth of the Northern Mariana Islands

FISHERIES DATA

Commercial:

- U.S fisheries accounted for six percent of total world commercial fishery landings in 1989.
- 5 thousand-million kilos (4.995 million metric tons), valued at $3.89 thousand-million were landed by U.S. commercial fishermen in 1990.
- 92,900 craft were used in commercial fishing activities in 1988.
- Approximately 274,000 men and women were engaged in commercial fishing full-time in 1988. An additional 90,000 persons were employed by 4,600 processors and wholesalers of fishery products.

Recreational marine fisheries: (data from Atlantic and Gulf of Mexico coasts only)

- Approximately 17 million U.S. marine recreational fishermen made 39.8 million fishing trips.
- Approximately 231 million fish (roughly 143 million kilos) were caught.
- 86 percent of these fishing trips occurred within 16 kilometers of shore.

Exhibit 6d.2

NON-LIVING RESOURCES

Off-Shore Oil and Gas Production

1.65 million square nautical miles (560 thousand-million hectares) of Outer Continental Shelf (OCS).*

- In 1989, 13.2 million hectares were under lease. Of that, 3.16 million hectares were under exploration, development and production for oil and gas.
- 8.5 billion barrels of oil and condensate were produced from federal waters in the OCS between 1954 and 1989.
- 2.46 million-million cubic meters of natural gas were produced from federal waters in the OCS between 1954 and 1989.

Year	Crude oil *(thousand-million cubic meters)*	Natural gas *(thousand-million cubic meters)*
1954	0.525	1.70
1972	65.480	84.95
1989	48.518	118.93

OIL SPILLS INVESTIGATED BY THE U.S. COAST GUARD IN 1982, 1986 AND 1989

Year	Vessels** *(cubic meters)*	Non-vessels *(cubic meters)*	TOTAL *(cubic meters)*
1982	14,383	24,981	39,364
1986	12,869	4,921	17,790
1989	51,476***	2,271	53,747

* This is the federal portion of the United States EEZ plus Continental Shelf Extensions covered by the Outer Continental Shelf Lands Act.

** Includes tankships, tank barges and other vessels;

*** On March 24, 1989, the *Exxon Valdez* spilled 40,878 cubic meters of crude oil into Alaska's Prince William Sound.

SOURCES:

Coastal Land and Water Area

U.S. Department of Commerce. National Oceanic and Atmospheric Administration. National Ocean Survey. Coast and Geodetic Survey. Chief Geographer.

U.S. Department of Commerce. National Oceanic and Atmospheric Administration. National Ocean Service. Strategic Assessments Branch. *Estuaries of the United States: Vital Statistics of a National Resource Base.* Rockville, MD: October 1990: 79pp.

U.S. Department of Commerce. National Oceanic and Atmospheric Administration, National Ocean Service. Rockville, MD: Ocean Assessments Division, in cooperation with Department of Interior. National Wetlands Inventory. Fish and Wildlife Service. Washington, D.C.; and the National Wetlands Research Center. Fish and Wildlife Service. Sidell, Louisiana. *Coastal Wetlands of the United States. An Accounting of A Valuable National Resource.* February 1991: 59pp.

U.S. Department of Commerce. National Oceanic and Atmospheric Administration. *The Coastline of the United States.* Washington, D.C.: U.S. Government Printing Office: 1975.

Fisheries Data

U.S. Department of Commerce. National Oceanic and Atmospheric Administration. National Marine Fisheries Service. *Fisheries of the United States, 1989. Current Fishery Statistics no. 8900.* 111pp., and *Fisheries of the United States, 1990. Current Fishery Statistics, no. 9000.* 111pp. Silver Spring, MD.: May 1990; May 1991.

Non-Living Resources

U.S. Department of the Interior. Minerals Management Service. *Federal Offshore Statistics: 1989: Leasing, Exploration and Revenues.* OCS Report MMS 90-0072: 1990: 104pp.

Oil Spills

U.S. Department of Transportation. U.S. Coast Guard. GMEP Office. Washington, D.C.

Increasing population and development are stressing U.S. coastal systems. Demand for prime coastal property for residential and industrial purposes has created intense competition and controversy over appropriate uses of these lands. Constructing harbors, industrial facilities and services for tourists and others leads to filling and draining wetlands, modifying shorelines to protect investments and increases in pollution loads.

Development in many coastal areas has "sprawled" across the landscape. Residential and industrial developments have replaced farms, forests, wetlands, woodlands, and fish and wildlife habitats. Between 43 and 51 percent of annual U.S. residential construction between 1970 and 1989 was in coastal areas. Some 6.7 million housing units were constructed in the nation's coastal areas during the 1980s. The most dramatic growth occurred in Florida and California, where almost 45 percent of the nation's coastal housing was built. Florida and California have lost 46 percent and 91 percent, respectively, of their original wetlands.

Natural coastal ecosystems have been disrupted by poorly planned or inefficient development patterns. Commercial fishing and industrial activities are especially vulnerable to rising property values along waterways. Condominiums and second- or vacation-home developers purchase dock space, particularly fish docks, and develop waterfront condominiums and marinas, displacing fishermen from this area. Development of recreational facilities in some undeveloped areas has created pollution from "point" and "non-point" sources, and destroyed fish and wildlife habitat. Coastal erosion and public access to beaches remain problems in many areas with high property values.

Additional leisure time has increased the demand for parks, recreational facilities and fishery resources. Excluding Hawaii, Alaska and the U.S. insular areas, over 27,000 recreation sites covering 114,400 square kilometers, under public ownership and/or management by local, state and federal governments, are in U.S. coastal areas. Local governments own the majority of these. Almost 4,000 of these sites are adjacent to tidally influenced waters, and about 1,500 are adjacent to the open ocean. Over 200 million hectares of federal lands are managed by the National Park Service and the Fish and Wildlife Service in Hawaii. In Alaska, over 51.6 million hectares are managed by the National Park Service and Fish and Wildlife Service. These areas are protected for public enjoyment.

Coastal areas support major population and transportation centers, commercial and recreational fishing industries, agricultural activities and industrial facilities. Traders, guides and equipment suppliers in coastal areas contribute thousands of millions of dollars to the national economy. Scenic and recreational appeal of coastal and marine areas greatly enhance many local economies. The economic base of many coastal communities centers on providing visitors with opportunities to enjoy beaches and related recreational activities such as swimming, surfing, fishing and boating. Tourism and related activities generate thousands of millions of dollars each year in coastal U.S. communities.

The offshore oil and gas industry in the coastal states (located primarily in the Gulf of Mexico, off southern California, and in the Arctic Ocean) is of national strategic and economic importance. Approximately 11 percent of the nation's oil production and 23 percent of the nation's natural gas production were produced from these areas in 1989.[5] (See Box 6d.1.) Thousands of millions of dollars of economically recoverable resources remain in the Gulf of Mexico and other outer continental shelf (OCS) areas; only about five percent of the total number of designated OCS tracts have been leased for energy exploration and development.[6] Coastal areas are also a potentially important source of non-energy mineral resources, including sand

U.S. COASTAL AREAS: ENVIRONMENTAL PROBLEMS

Over the past several decades, the United States has made substantial progress in correcting poor resource management practices. This includes curbing the loss and modification of some types of coastal habitats, and reducing environmental loadings of some types of contaminants such as nutrients, certain pesticides and toxic industrial chemicals. However, many of our coastal areas continue to suffer from over-utilization, continuing losses of important habitat and damage from pollution. For example:

- Striped bass have shown a steady decline over the past 15 years in almost every estuary on the Atlantic and Gulf coasts. Salmonid populations continue to drop in San Francisco and Willapa Bays, and the Columbia River. Other interjurisdictional and estuarine species, such as sturgeon, shad, redfish, oysters and dungeoness crab are also declining in at least part of their ranges. Maryland's oyster harvest has declined more than 90 percent from levels of a century ago.

- Waterfowl are declining in all coastal areas. Black duck, canvasback, redhead, pintail, blue wing teal, scaup and cackling Canada goose populations are showing significant declines.

- Coastal wetlands, which support many fish and wildlife species, are still being lost in many areas. In Louisiana alone, there is an estimated loss of 12,800 hectares of coastal wetlands annually.

- Submerged aquatic vegetation, which is a source of food and essential habitat for many aquatic species, has decreased drastically in several estuaries in recent times, including the Chesapeake, Tampa, Mobile, Galveston, San Francisco and Willapa bays, and the Laguna Madre. At least 65 percent of the submerged aquatic vegetation present in the Chesapeake Bay in 1960 had been lost by 1988.

- In 1990, of the 6.88 million hectares of estuarine waters that were classified for harvest, 37 percent are harvest-limited. In Louisiana in 1985, harvest from 24 percent of the state's classified estaurine wasters was prohibited. In 1990, this had risen to 35 percent.

- Restrictions or health advisories for the consumption of certain types of fish and shellfish are in effect in many coastal areas.

- Beach closures due to bacterial contamination or presence of debris, including medical wastes, remain a problem in some areas.

and gravel, phosphorite, manganese nodules, cobalt-ferromanganese crusts and polymetallic sulfides.

The United States has many federal, state and local programs to manage and protect marine areas and resources subject to its jurisdiction. These include the Coastal Zone Management Act (CZMA), Marine Protection, Research and Sanctuaries Act, the Clean Water Act (CWA), the Magnuson Fishery Conservation and Management Act (MFCMA), the Outer Continental Shelf Lands Act (OCSLA), the Oil Pollution Act of 1990, among others. A description of these environmental laws is presented in Chapter 5. State and federal coastal-zone management programs are intended to balance development and use of coastal resources with environmental and social

considerations. These programs encourage multiple use and long-term protection of U.S. coastal areas.

More than half of the U.S. population resides in coastal areas. These coastal areas account for less than 10 percent of the nation's land. A number of approaches have been taken to manage the effect of population growth on the coastal environment. The Coastal Zone Management Act of 1972, for example, established a national framework for coastal resources management to assist states and insular areas in developing the capability to manage their coastal resources. The federal government provides financial and technical assistance and policy guidance to states and territorial governments to prepare and implement programs. State and local governments must balance the use and conservation of coastal and ocean resources. The federal government has invested over $600 million in these state programs. Twenty-nine coastal states and insular areas covering 94 percent of the U.S. coastline now have federally approved coastal zone management programs. In 1990, the act added a requirement for states and insular areas with approved CZM programs to develop coastal non-point pollution control programs. State programs must contain enforceable policies and mechanisms to reduce non-point sources of pollution and protect coastal waters.

Individual U.S. states take the lead role in other programs such as the National Estuary Program. This program, created under the Clean Water Act, identifies significant estuaries, and establishes a process for improving and protecting water quality and enhancing coastal resources in the estuarine ecosystem. An estuary is nominated by a state governor and approved by the federal government. A Comprehensive Conservation Management Plan (CCMP) for managing the estuarine watershed is developed cooperatively with the participation of all interested parties. These include the appropriate government agencies, elected officials, academic institutions, interest groups and the public. The CCMP identifies the specific actions needed to restore and maintain the estuary and establishes a schedule for implementation. The program currently includes 17 estuaries.

Characterization of the U.S. Coastal Areas and Resources[7]

Northeast Atlantic

Along the Northeast Atlantic coast, rocky tidal shorelines and islands are the dominant geologic feature. Estuaries are generally small. Boston, Massachusetts is the only major urban area. Forested areas predominate in this region. Harvesting is allowed in 83 percent of the shellfish growing areas (approximately 3,120 square kilometers). Over 325,000 metric tons of seafood valued at over $542 million were landed in the region in 1990. Lobsters, scallops and cod are the commercially important species. The Northeast Atlantic region has the fewest point sources of pollution and the lowest rate of pesticide application of all the regions.

Middle Atlantic

The Middle Atlantic is the most densely populated coastal region of the United States. It contains the greatest percentage of urban land, and includes New York City and Washington, D.C. Nevertheless, forest and agricultural land uses dominate in this region. Sixty percent of the wetlands in this region are found around the Chesapeake and Delaware bays. Approximately 84 percent of the 19,500 square kilometers of classified shellfish growing areas are approved for harvesting. About 550,000 metric tons of seafood worth approximately $310 million were landed in this region in 1990. Major fisheries of the region include the sea scallop and estuarine-dependant blue crab. Estuaries in this area provide important habitat for striped bass and bluefish.

Southeast Atlantic

The Southeast Atlantic coast is characterized by two shorelines: lagoons fronted by barrier islands and low-lying marshy shoreline formations. The population density varies significantly from sparsely populated areas of North and South Carolina to high densities in Florida. Extensive forests cover the landscape adjoining several estuaries, such as the Albemarle/Pamlico Sounds. Agriculture is also a major land use. This region contains the second highest amount of wetlands of all the regions. Harvesting is allowed in over 75 percent of the classified shellfish waters. Over 131,000 metric tons of seafood valued at $169 million were landed in the region in 1990. Estuarine-dependant species, including shrimp, crabs and menhaden accounted for over half of the harvest. Municipal wastewater treatment plants and pesticides applied to agricultural lands are the major sources of coastal pollution.

Gulf of Mexico

Large shallow estuaries dominate the Gulf of Mexico coast. They provide important habitats for many estuarine-dependant living resources. Abundant wetlands are found in this area. Significant wetland losses are occurring due to natural erosion, accelerated erosion caused by river diversions, damming and channelization, and pollution. Conversion to agriculture has been a major cause of loss of wetlands in the Mississippi delta and Florida Everglades. Agricultural and forestry activities are the most prevalent land uses. Although only five percent of the region is considered urban, the Gulf of Mexico region is the second fastest growing coastal area. Most of the region's population is concentrated in Florida and Texas. Approximately 42 percent of classified shellfish-growing waters are open for harvesting. In 1990, the Gulf of Mexico region landed almost 800 metric tons of seafood valued at $640 million. Shrimp landings are second to menhaden in volume, but accounted for more than half of the value of all landings. The Gulf of Mexico has more point sources of pollution than any other region. Over half of these point sources are associated with the petrochemical industry. Farmers in the Gulf of Mexico apply more pesticides to their crops than in any other coastal region.

Pacific

The Pacific region has the second highest percentage of urban land. Forests are the major land use along the coast and estuaries north of San Francisco Bay. Next to the Northeast Atlantic coast, the Pacific has the fewest point sources of pollution and the lowest amount of pesticide application of coastal regions. The Pacific region contains the least amount of coastal wetlands. Harvesting is limited in more than 70 percent of the approved shellfish-growing waters. This region landed 310,000 metric tons of seafood valued at $315 million in 1990 in this region. Over half of the total value is from anadromous salmon fisheries.

Alaska

Alaska has two distinct types of coastlines: deep glacial fjords and wide dendritic fluvial plains. Coastal bays and rivers provide important habitats for major runs of anadramous fish, marine mammals and commercially sought species. Millions of seabirds nest and marine mammals haul out on numerous islands around the coast. Pacific cod, pollock and other trawl-caught species dominate fish landings in Alaska. In 1990, the fishing industry landed approximately 2.7 million metric tons of seafood products valued at over $1.5 thousand-million in Alaskan ports.

Hawaii

The Hawaiian islands, a chain of volcanic islands, rise from the seafloor in the tropical Pacific. Forested land dominates in Hawaii, and much of the coastline is undeveloped. The population is concentrated on Oahu, one of the eight major islands. Tourism is a major part of the economic base of the state. In 1990, over 6 million visitors generated over $9 thousand-million in the

tourist industry. In 1990, 1,300 metric tons of seafood valued at $6.5 million were landed in Hawaii.

Insular Areas of the Pacific and Caribbean

Insular areas under U.S. sovereignty or administration range from coralline-fringed volcanic seamounts of American Samoa, Guam, Palau and the Commonwealth of the Northern Mariana islands in the Pacific, to the U.S. Virgin Islands and Puerto Rico in the Caribbean. Approximately 30 percent of the U.S. EEZ lies in the insular areas. Fishing for tuna and nearshore reef species and tourism are important components of the economies of many Pacific islands. Tourism, light industry and petroleum refining are integral to the economic base of the U.S. Virgin Islands and Puerto Rico. Chapter 3 on indigenous peoples gives a more detailed description of these insular areas.

Ocean Resources

Living Marine Resources

Over 20,000 species of fish and shellfish inhabit marine, estuarine and freshwater ecosystems in the waters of the United States. Of these, approximately 300 species are fished for commercial and recreational purposes. Many species are enjoyed in their environment for their aesthetic value.

Commercial Fisheries. During the 1960s and 1970s, foreign distant water fleets exploited highly productive waters off the United States such as the Georges Bank region. Foreign factory freezer trawlers revolutionized deepwater commercial fishing. In 1976, Congress enacted the Magnuson Fishery Conservation and Management Act. Through eight regional fishery management councils, fisheries resources within the EEZ are managed for their maximum sustained and optimum yield. States regulate the nearshore fisheries within their coastal waters.

Since 1976, the United States harvesting capacity has increased allowing a higher proportion of the maximum sustainable and optimum yield within the U.S. EEZ to be harvested the U.S. fishing fleet. For certain fisheries, however, the average catch per unit effort has declined. Reasons for these declines vary. Over-exploitation of target and non-target species, coastal habitat alteration, and point and non-point source pollution discharges have had major impacts on fishery resources.

Total landings and their value have increased substantially since 1970. Exhibit 6d.3 illustrates the trends in total landings and their value from 1970 to 1989. Almost 5 million metric tons of edible fish and shellfish and industrial fishery products were landed by U.S. commercial fishing operators in 1990. The total value of this harvest was worth $3.89 thousand-million. This compares with landings of 2.2 million metric tons of fish and shellfish valued at $602 million in 1970. In 1970, Americans consumed approximately 5.13 kilos of edible seafood per person. By 1990, consumption had increased to 7.2 kilos per person.

Marine species comprise 85 percent of the commercial, non-aquaculture catch of seafood in the United States. In 1990, 1.44 million metric tons of pollock were landed from the Bering Sea and Gulf of Alaska. This catch alone accounted for approximately 30 percent of the total commercial landings and was valued at $272 million. The other important fisheries landings were: 900,000 metric tons of menhaden valued at $94 million from the South Atlantic and Gulf of Mexico; 330,000 metric tons of salmon from the Pacific Northwest and Alaska valued at $612 million; and 157,000 metric tons of shrimp from the Gulf of Mexico valued at $491 million.[8]

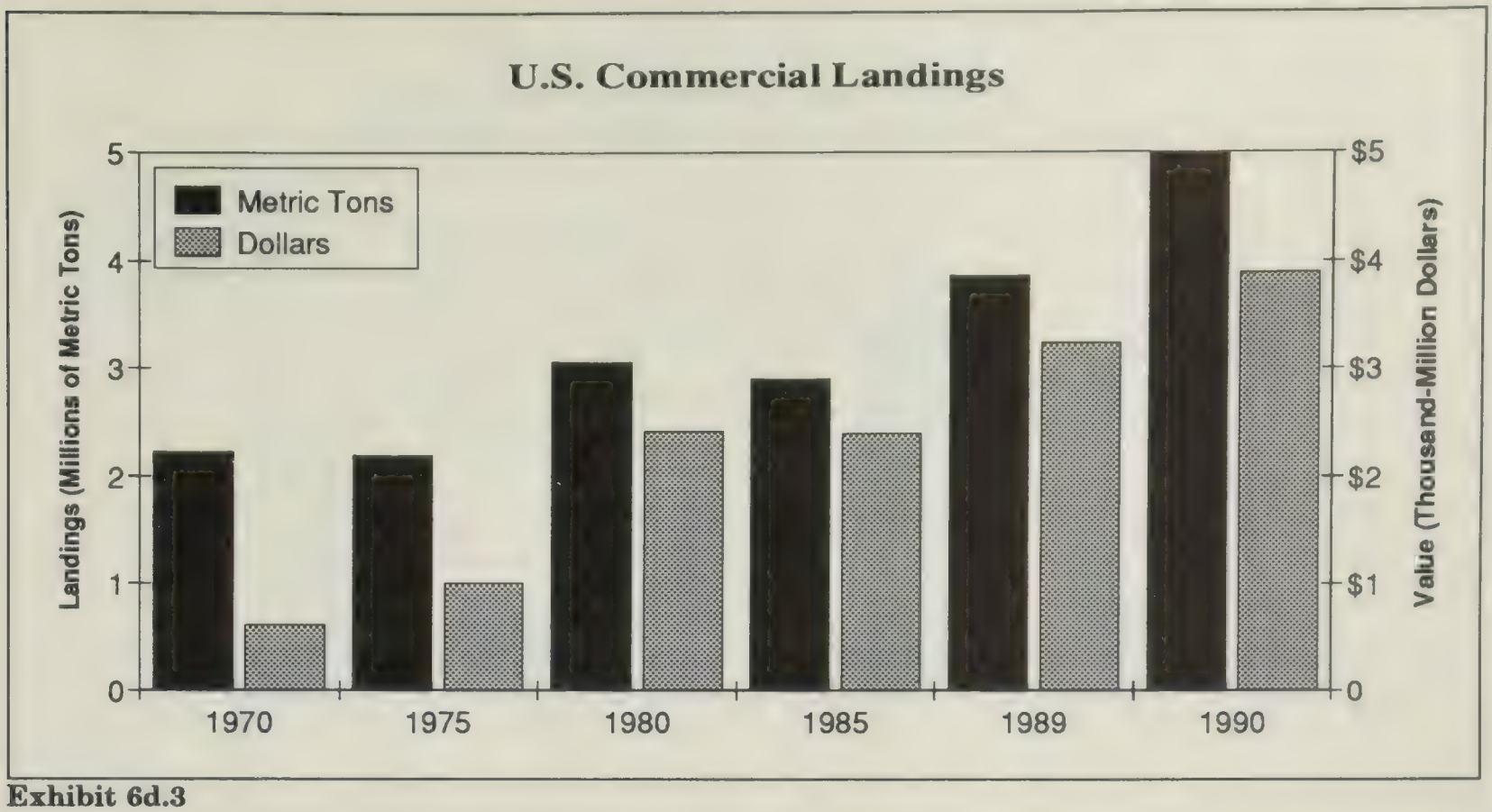


Exhibit 6d.3

A 1989 survey of commercial fisheries resources of the United States concluded that of 81 commercially harvested stocks (i.e., species or species groups):[9]

- 14 are over-exploited and another 36 are fully exploited;
- 10 of 14 over-exploited stocks would require five to 20 years to recover if fishing stopped altogether, but commercial fishing continues in eight of these 10 fisheries;
- Nearly 30 percent of all species and stocks studied have experienced population declines since 1977;
- Insufficient information exists on the status of 29 percent of U.S. fisheries.

Aquaculture. Although the U.S. aquaculture industry is relatively new, it is expanding rapidly. Aquaculture of some species is especially important in certain U.S. regions. Catfish, trout and salmon are among the most valuable species cultured in the United States. In 1989, 373.5 million kilos, worth $740 million of aquacultured species were produced by the U.S. aquaculture industry.[10]

Marine Recreational Fisheries. Fishing is one of the most popular recreational activities in the United States. In 1990, approximately 143 million kilos of marine fish were caught during an estimated 39.8 million fishing trips. Popular marine sportfish include bluefish, mahi mahi, spotted seatrout, sea bass, marlin, striped bass, red drum, weakfish, summer and winter flounder, sharks and Atlantic croaker in the Atlantic and Gulf of Mexico regions. Mackerel, smelt, striped bass, rockfish and flounder are species caught on the Pacific coast. Most recreational fishing occurs within 16 kilometers of the shore. Although the number of marine recreational fishing trips has remained relatively constant, as Exhibit 6d.4 illustrates, the total annual catch has declined substantially since 1980.[11]

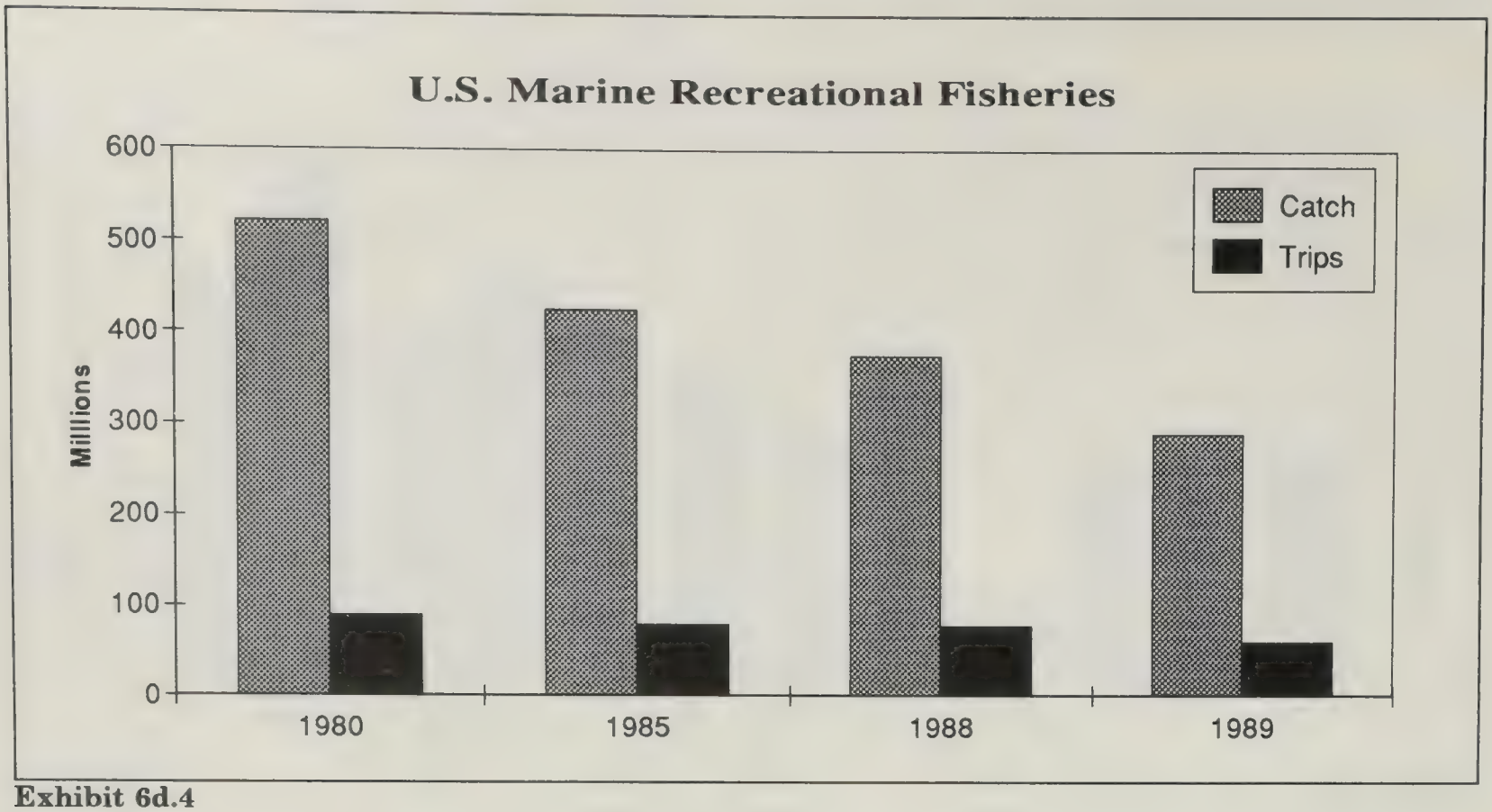


Exhibit 6d.4

Marine Mammals. All marine mammals found in the waters of the United States are protected by the Marine Mammal Protection Act (MMPA). Ten species of large whales, 34 species of small cetaceans (porpoises and dolphins), 13 species of pinnipeds (seals, sea lions and walrus), and five other species (sea otters, polar bear, manatee and dugong) of marine mammals spend part or all of their time in waters of the United States and its insular areas. Population levels of manatees, Hawaiian monk seals, northern right whales, humpback whales, California sea otters, Stellar sea lions and the Gulf of California harbor porpoises are much lower than historical levels and have been designated as endangered or threatened.[12] The MMPA, enacted in 1972, was the first national law to prohibit taking (defined as actual or attempted killing, hunting, capturing, harming or harassing) of marine mammals. The MMPA allows taking by permit for scientific research, public education, enhancing the survival or recovery of a species or stock, and by Alaska Natives for subsistence and handicraft purposes. Small numbers of marine mammals may also be taken incidental to commercial fishing activities and specified activities other than commercial fishing, if the federal government determines that such taking will have a negligible impact on the marine mammal species. Concerns that led Congress to enact the MMPA included: declining populations, particularly of large whales; calls for a global moratorium on commercial whaling; and the incidental capture of marine mammals by commercial tuna fishermen, particularly in the eastern tropical Pacific.[13] The box on the next page highlights advances in the protection of marine mammal populations since enactment of the MMPA.

Marine Turtles. The five species of sea turtles which are listed by the Endangered Species Act (ESA) as endangered or threatened are green, hawksbill, Kemp's ridley, leatherback and loggerhead. Despite protection under the ESA, incidental capture in commercial shrimp trawls, loss of nesting habitat and marine pollution have prevented turtle populations from recovering. Scientists have identified incidental capture of sea turtles in commercial shrimp trawls as the single most serious threat to population

Marine Mammal Protection Act

Several significant changes have occurred since the United States Congress passed the Marine Mammal Protection Act (MMPA) in 1972:

Eastern Pacific population of gray whales recovers.
Population estimates indicate that the eastern Pacific population of gray whales numbered 15,000 to 20,000 prior to the initiation of commercial exploitation in 1846. By the turn of the century, the population was severely depleted. All commercial whaling on the species ceased in 1946. The population has recovered to the pre-exploitation levels, which is currently estimated at 21,000 animals. Between 1967 and 1988, the population grew at an annual rate of 3.2 percent (Breiwick and Braham, 1984).

Dolphin captures by U.S. tuna fishermen reduced over 90 percent.
In 1972, American tuna fishermen killed 423,678 dolphins in purse-seine fishery in the eastern tropical Pacific. By using new gear, United States fishermen reduced incidental capture to less than 20,000 per year in the 1980s. In 1990, three U.S. canneries—suppliers of nearly 75 percent of canned tuna consumed nationwide—terminated purchase of tuna caught in dolphin-threatening operations. In 1990, the observed kill of dolphins by U.S. fishing boats was 5,083 (Hall and Boyer, 1990).

Commercial fur seal harvests ended.
A commercial harvest of Northern fur seal for their pelts was conducted under the supervision of the U.S. government in the Pribilof Islands from 1916 to 1984 under the North Pacific Fur Seal Convention. The meat from these animals was also used for subsistence by the Pribilof islanders. Beginning in 1985, the harvest has been for subsistence use only and the kill was limited to 3,713. The kill since then has been less than 2,000 per year. The population has been declining for many years and is considered depleted. The current population of fur seals in the entire eastern Bering Sea is thought to be 871,000 (U.S. Fish and Wildlife Service, 1990).

Sea otter populations in Alaska are thriving.
Between 1742 and 1911, commercial fur hunters reduced sea otters in Alaska to extremely low population levels. Since sea otters are now protected under the MMPA, their numbers and distribution in Alaska continue to increase. Between 1965 and 1969, 402 sea otters were translocated to six sites in southeastern Alaska. Nearly 4,000 sea otters were counted in the same areas between 1987 to 1988. Most recent population estimates put the number of Alaska sea otters at between 100,000 and 150,000 (U.S. Fish and Wildlife Service, 1990).

Florida manatee populations currently number between 1,200 to 2,000.
The most recent survey counted 1,465 manatees. Species decline has been linked to killing or injury of animals by vessels in Florida waterways, degradation of habitat by extensive coastal development, and episodes of intense cold weather beyond the animals' ability to survive. Recovery programs by local, state, federal government, and non-profit organizations have targeted increased scientific research and public education as tools to halt species decline. In spite of these efforts, known annual mortality from all causes has been increasing (Marine Mammal Commission, 1991).

recovery of loggerhead and Kemp's ridley turtles. In 1987, the federal government required commercial shrimp trawlers to use Turtle Excluder Devices (TEDs) to minimize the then-estimated annual loss of 50,000 sea turtles drowned when taken incidentally in shrimp nets. Since implementation of these regulations, the number of dead sea turtles washing ashore on beaches during shrimping season has dropped dramatically.[14]

Specially Protected Areas

The section on plants, animals and biodiversity addresses specially protected aquatic and terrestrial areas. Areas within U.S. maritime zones which are

representative of various ecosystems have been set aside for the conservation of plant and animal species.

National Marine Sanctuaries.[15] National Marine Sanctuaries range in size from less than 1 to over 2,600 square nautical miles (over 883,000 hectares). These sanctuaries harbor a diverse array of marine plants and animals, from huge whales to tiny brightly colored sea snails. In many cases, these protected waters provide a secure habitat for marine species close to extinction. The nine national marine sanctuaries represent distinct marine environments in temperate and tropical areas, such as nearshore, open water and benthic (or ocean floor) ecosystems. They are: Gulf of the Farallones (northern California); Channel Islands (southern California); Cordell Bank (northern California); Gray's Reef (Georgia coast); the MONITOR (North Carolina); Fagatele Bay (American Samoa); Florida Keys including Looe Key and Key Largo. Additional locations are in the process of being designated.

National Estuarine Research Reserves.[16] Currently, there are 19 National Estuarine Research Reserves (NERR) preserving approximately 120,000 hectares of estuarine waters and salt and freshwater wetlands. These areas are protected for support of long-term research. NERR sites are selected which represent biogeographical and typological ecosystems of U.S. mainland and trust territories. Four NERR's are located in the Gulf of Mexico and the Caribbean, eight on the Atlantic coast, one in the Great Lakes, and five in the Pacific. The most recent addition, the Chesapeake Bay National Estuarine Research Reserve in Virginia, was designated in June 1991. It protects nearly 1,200 hectares of wetland and upland habitat. Additional sites are currently being developed.[17]

National Park Service. The National Park System has many holdings in coastal areas in the United States and its territories. These coastal areas not only provide spectacular scenery, but allow for conservation, protection and research of wildlife, plants, and natural and cultural resources. Coastal and riparian parks include: the Everglades (Florida), Channel Islands (southern California), Acadia National Park (Maine); Big Cypress National Preserve (Florida); Pu'uohonua o Honaunau (Hawaii); Buck Island Reef (Virgin Islands), and Fort Jefferson (Dry Tortugas, Florida) National Monuments; USS Arizona Memorial (Hawaii); Sitka National Historical Park (Alaska); Assateague Island (Virginia) and Point Reyes (California) National Seashores.[18]

National Wildlife Refuges. The National Wildlife Refuge System is a unique and highly diverse network of over 36 million hectares of lands and waters in the United States. Over 470 national wildlife refuges are managed to conserve and enhance populations of fish and wildlife and their habitats. There are over 150 coastal refuges that provide nursery areas for anadromous, estuarine and marine fish, habitat for nesting and wintering migratory waterfowl and seabirds, and the necessary environment for the enhancement of endangered or threatened species such as manatees. Some of these coastal refuges include: Yukon Delta (Alaska), San Juan Islands (Washington), Howland Island (U.S. Pacific insular area), Arkansas (Texas), Key West (Florida) and Chincoteague (Virginia).

Challenges: Ongoing and in the Future

Federal and state regulatory agencies are facing many challenges regarding the management and conservation of the nation's living marine resources and their habitats. Many are currently being addressed through various federal programs. These include: addressing the competition for resources among

commercial, recreational and indigenous fishermen; improving the effectiveness of international fisheries relationships with foreign fishermen; reducing bycatch/incidental catch; improving predictability of stock assessments; improving compliance with fisheries management regulations; resolving conflicts between Marine Mammal Protection Act, Endangered Species Act and fisheries; rebuilding overfished marine fisheries; protecting living marine resource habitat; assessing the effects of climate change on living marine resources and their habitats; and improving the safety of seafood for human consumption.[19]

Non-Living Marine Resources

The continental shelves off the Atlantic, northwestern and southwestern Pacific (Alaska and California), and Gulf of Mexico coasts contain significant mineral and energy resources. The United States manages the minerals, natural gas and oil resources of the outer continental shelf (OCS) under the Outer Continental Shelf Lands Act (OCSLA). The OCSLA authorizes leasing publicly owned offshore areas to private companies for environmentally sound extraction of sub-seabed mineral resources. Exploration and development may occur only after analysis of potential environmental impacts, compliance with federal environmental laws and compliance with state coastal-zone management plans. From 1973 to 1988, the federal government spent over $500 million dollars on studies relating to the effects of OCS development on the marine, coastal and human environments.[20]

Oil and Gas Deposits. The federal OCS encompasses approximately 560 million hectares. Of this total, 13.2 million hectares were under lease to oil and gas exploration, development and production companies during 1989. In 1989, the OCS oil and gas program generated more than $2.9 thousand-million in production royalties and lease-related revenues for the federal government. Approximately 1.35 thousand-million cubic meters of oil and 2.46 million-million cubic meters of natural gas have been produced from the OCS between 1954 to 1989. An additional 651.8 million cubic meters were produced from the states' waters during this period for a U.S. EEZ total of about 2 thousand-million cubic meters. Between 1971 and 1988, oil production from OCS wells averaged almost one million barrels per day. In 1972, the OCS supplied almost 14 percent of the U.S. production of natural gas and 12 percent of the oil produced. By 1989, the OCS supplied almost 24 percent of all natural gas produced in the U.S and more than 10 percent of the nation's oil production.[21]

Balancing development of oil and gas resources on the outer continental shelf with protecting the coastal and marine environments and their living resources has been controversial. In response to public concern over adverse environmental effects of OCS oil and gas activities, and in light of some uncertainties in the scientific analysis of potential ecological and social impacts of offshore development, in June 1990, President George Bush announced a delay on OCS leasing until after the year 2000 in many areas off California, Florida, the Pacific Northwest and the North Atlantic. The Oil Pollution Act of 1990 initiated a comprehensive federal oil spill liability, compensation, prevention and response program. This act established a $1 thousand-million trust fund to improve prevention and cleanup of oil spills. The act includes monies for cleanup activities, improving the safety of marine transportation of oil and research. It also imposed a moratorium on oil and gas leasing off the North Carolina coast.

Mineral Deposits. Blanket deposits of sand and gravel, placer deposits containing gold, platinum, chromite and titanium, polymetallic sulfides containing copper, lead, zinc and other minerals, ferromanganese crusts and

nodules, and thick beds of phosphorite occur on the ocean floor in the U.S. EEZ. At present, there are no mining operations in the U.S. EEZ; however, sand and gravel are dredged from the entrance to New York Harbor and sold for commercial use. Gold was mined in Alaskan state waters near the city of Nome from 1986 to 1990. Sand is also dredged periodically from state coastal waters for beach nourishment.

Coastal and Marine Pollution

In the 1970s, municipal sewage and contaminants in industrial wastewater were the primary sources of pollution. The construction of sewage treatment plants in coastal cities and installation of wastewater treatment plants at industrial facilities during the past two decades has curtailed many of the problems caused by these sources. Additional efforts currently underway should address remaining sewage treatment problems.[22] Non-point sources, stormwater, and combined storm and sanitary sewers, remain the largest challenges to fully addressing coastal pollution.

Coastal Pollution

Growing coastal populations are generating an increasing amount of municipal sewage, urban runoff, and marine debris. Industrial manufacturing and processing plants, landfills, dock and marina structures, agricultural runoff and littering by the general population also contribute to marine pollution problems. The United States has initiated a number of measures to combat coastal pollution problems. The status of some of these programs is discussed below. In addition, special programs have been established for the Chesapeake Bay and Gulf of Mexico.

Sewage Treatment. In the past, one of the most severe sources of coastal pollution was municipal sewage. In some areas, coastal waters subject to limited tidal flushing action received sewage treated by only very basic, or primary, treatment procedures, and some received entirely untreated sewage either all the time or when rainfall overloaded combined storm and sanitary sewer systems. More municipal sewage is now treated prior to discharge into coastal as well as fresh waters. The U.S. population served by sewage treatment facilities providing secondary treatment or better has increased from 85 million in 1972 to 144 million in 1988 and the population served by raw discharge facilities has dropped from five million to one million during the same period.[23] Significant improvements in coastal water quality have been achieved for many of the nation's coastal cities since implementation of secondary, and in a few cases tertiary, or advanced, wastewater treatment. However, in a few of the nation's largest and oldest cities, such as the Boston, Massachusetts metropolitan area, antiquated treatment plants have not yet been fully upgraded; improvements have been undertaken in the past several years. Rebuilding sewer systems to separate combined sanitary and storm sewers also presents formidable problems due to the high cost and logistic difficulties of rebuilding old sewer systems in extremely dense population centers such as the New York and Boston metropolitan areas.

Non-point and Other Diffuse Sources. Non-point source runoff from agricultural and urban areas has been more difficult to control. The United States continues to use focused geographic approaches designed to protect particularly fragile or threatened coastal areas from non-point and other diffuse sources. Model urban runoff/stormwater programs are in place for Puget Sound in the state of Washington and in several other cities; these programs have demonstrated reductions in toxic and other pollutant loadings.

Agricultural management practices are being implemented through voluntary programs specifically aimed at coastal protection in the Chesapeake Bay, the North Carolina sounds and other coastal areas. Some states also limit suburban development and other construction in buffer zones along their estuarine coastlines. However, continuing development and incomplete protection against non-point source impacts continue to threaten water quality in many coastal areas. The United States is trying a new approach under the 1990 amendments of the Coastal Zone Management Act. The act combines water quality and coastal zone management activities into Coastal Non-point Pollution Control Programs, which coastal states are required to develop by the end of 1994.

One area currently receiving increased recognition and remaining to be addressed is the contribution of airborne sources of nutrient and toxic pollutants. Airborne sources of pollutants deposited into coastal water bodies are now estimated, in some cases, to contribute from 10 to 46 percent of nitrogen loads and significant portions of phosphorus loads to some major northeast estuaries.[24]

Direct and Indirect Industrial Discharges. Direct discharges into coastal waters from industrial point sources have been markedly controlled in the past 20 years. Large proportions of previously released toxic and conventional pollutants have been removed from the waste streams of many large industrial and manufacturing facilities. This has resulted in improved coastal water quality in the immediate vicinity of the plants. Development of regulations for some additional industrial categories which are not yet covered, as well as revisions to existing regulations, are expected to bring about additional reductions in the discharge of toxic and conventional water pollutants.

Additional efforts are needed to adequately control toxic water pollutants from industrial and commercial facilities that discharge waste to municipal sewage treatment plants. The program for controlling these industrial releases, called the pretreatment program, requires each municipality to regulate these "indirect" dischargers. Most sewage treatment plants have not been designed to treat toxic pollutants. These pollutants can kill microbes that are part of the treatment process at the sewage treatment plant. Therefore, most industrial facilities must "pretreat" their effluent before discharging to the municipal sewer system. Pretreatment programs are now in place in almost all large municipalities. However, compliance monitoring difficulties combined with municipal budget constraints have made this a difficult program for some cities to conduct with full success.

Cumulative "Minor" Point Source Effects. Toxic and conventional pollution of the coastal environment from a myriad of small commercial, industrial or resource extraction facilities has not yet been adequately addressed. These facilities have sometimes not been thoroughly controlled because a higher regulatory priority has been placed on large dischargers to achieve the largest individual pollutant load reductions. However, in some areas it appears that concentrations of many "minor" facilities are causing serious coastal water quality impairments.

Floatables, Non-Biodegradables and Other Trash. Floatable trash is an aesthetic problem and poses serious ecological risks. Several states and municipalities have begun major trash cleanup programs, often mobilizing

CASE STUDY

THE CHESAPEAKE BAY PROGRAM

The Chesapeake Bay, with a surface area of 5,720 square kilometers, is the largest estuary in the United States. It is fed by 150 tributary rivers and streams, and supports 2,500 species of plants and animals and 13 million people.

In recent decades, the bay suffered serious declines in quality and productivity. In 1975, elevated public concerns led to a $27 million, Environmental Protection Agency-directed study of the causes of the decline. Overabundance of phosphorus and nitrogen was seen as the dominant cause of explosive algal growth that blocked out sunlight which bay grasses needed to survive, and depleted dissolve oxygen levels essential to all bay life. These conditions triggered a downward spiral of plants and animals competing for the depleted oxygen. The main sources of the excess nutrient loads include agricultural lands, specifically fertilizers and animal wastes, as well as urban and suburban waste discharges and runoff, and atmospheric deposition.

Though numerous federal and state pollution control and resource restoration programs were in operation, they were fragmented and unfocused. The EPA study recommendations provided a framework for coordinated, goal-driven actions by the three bay-bordering states (Maryland, Pennsylvania and Virginia), the District of Columbia, the Chesapeake Bay Commission (an interstate body for legislative coordination) and the federal government. To reduce algal growth and its impacts on submerged aquatic vegetation and dissolved oxygen levels, a 40-percent reduction in nitrogen and phosphorous loadings to the bay became a dominant goal of the 1987 Chesapeake Bay Agreement.

The Chesapeake Bay restoration has proceeded on many fronts. These include improved sewage treatment, phosphate detergent bans, better compliance with environmental requirements by federal facilities, reduced fertilizer use and improved animal waste management, better erosion control, a moratorium on striped-bass fishing, and construction of a fish passage facility at Conowingo Dam on the Susquehanna River. Plans are underway or already being implemented to restrict shoreline development, further improve controls on urban and farm runoff, protect wetlands, reduce pollutant discharges from recreational boats, improve fisheries management and limit discharges of toxic chemicals.

Bay water quality improvements reported in 1991 included a 20-percent reduction in total phosphorus since 1985, even though wastewater flows from municipal sources continued to grow. This progress is attributed primarily to reductions of phosphorus loadings from point source discharges. But non-point source control efforts on farm lands and a ban on phosphate detergents also contributed to reductions. Submerged aquatic vegetation, the most sensitive indicator of overall water quality improvement in the bay, increased its coverage in the mid-bay by 57 percent since 1984. Striped bass are increasing, again allowing sport and commercial fishing for this popular fish.

Nitrogen levels, however, have continued to rise due mostly to continuing population growth and related increases in wastewater flows without removal of their nitrate content. A major reduction is expected from the 30-percent cut in nitrogen fertilizer use. But this result will take some time to show up because nitrogen travels from fields to the bay predominantly through groundwater, a process that takes several years. Another concern is nitrogen deposition from the air (primarily from power plants and vehicle emissions), which may constitute nearly 40 percent of the loadings to the bay from human sources.

The parties to the 1987 Chesapeake Bay Agreement are currently reevaluating their commitment to a 40-percent reduction of phosphorus and nitrogen entering the bay by the year 2000. This evaluation is expected to provide a refined bay-wide nutrient reduction commitment, including basin-specific nutrient reduction targets and revised strategies to achieve the water quality and living resources goals.

citizen volunteers and instituting public education campaigns. In 1990, 109,000 volunteers nation-wide cleared 5,850 kilometers of coastline and collected more than 1,320 tons of trash.[25] New York City has been re-examining the management of its enormous solid waste stream in an effort to minimize contributions to the sea via storm sewers, spills from trash barges and other sources. The United States is working toward better control of storm sewers and combined sewer overflow and expects these controls to reduce the release of floatables from these sources.

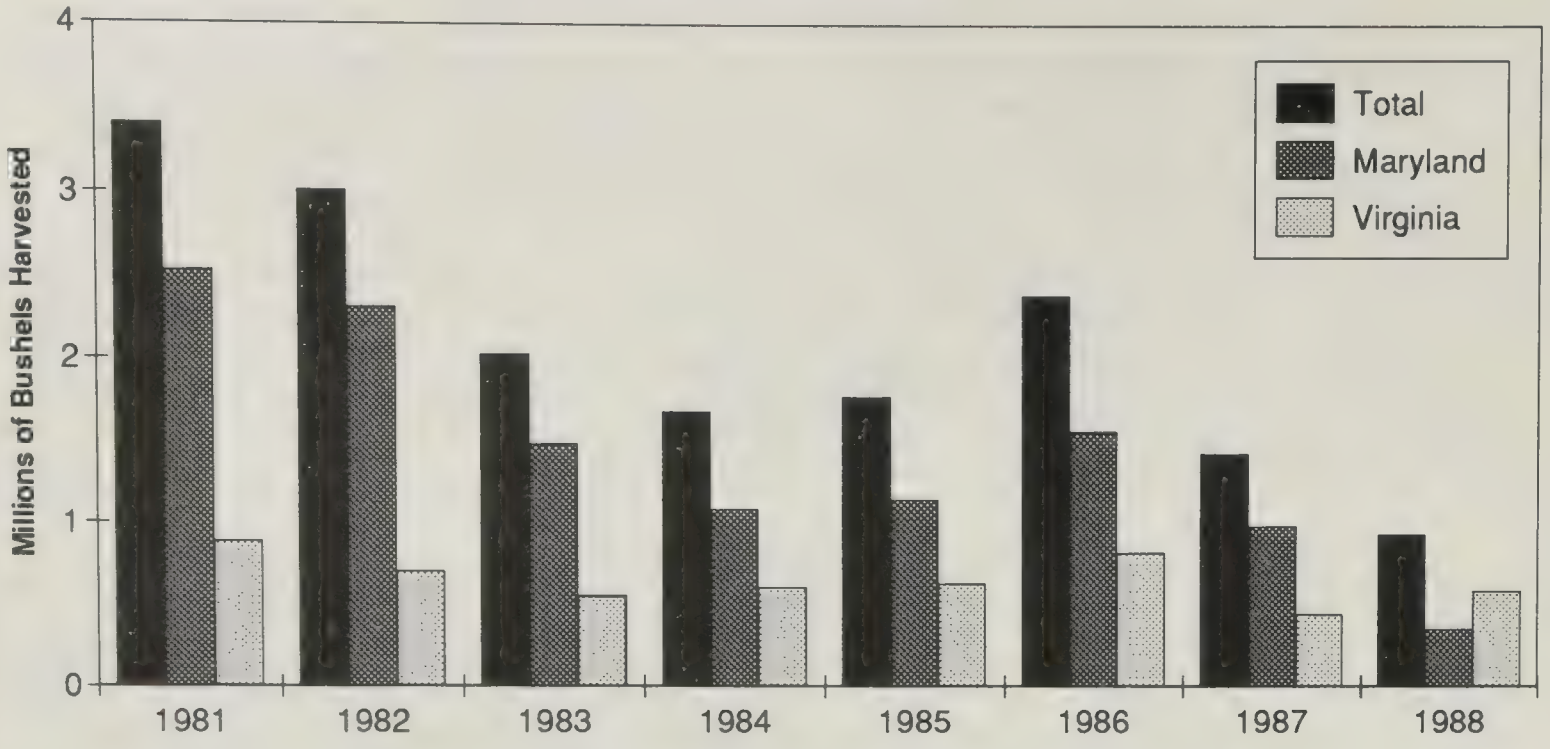
Open Ocean Pollution

Since the early 1970s, major progress has been made by the United States in controlling pollution in the open ocean. Ocean waters within the U.S. EEZ are relatively unpolluted compared to near-shore coastal waters. This is in part because pollutants disperse in the open ocean, but also because the United States has significantly reduced most direct ocean releases of pollutants. Material being disposed of in open ocean areas along the U.S. outer continental shelf now consists primarily of oil and gas drill rig discharges (mainly from drill cuttings with some drilling mud), sediments from dredging operations and ship discharges. Strict regulations limit materials that can legally be disposed of in the open ocean. Federal agencies have taken steps to discourage the use of some kinds of fishing gear and other shipboard equipment that increase the amount of trash in marine waters.

Ocean Dumping of Sewage Sludge. Dumping of sewage sludge increased from 4.8 million tons in 1973 to 8.7 million tons in 1989. Until 1986, sludge from nine New York and New Jersey sewage authorities was dumped at a site 19 kilometers offshore. In 1986, this dumping was moved to another site 170 kilometers offshore. Six of these nine sludge dumpers terminated their operation in March 1991. Two more will cease dumping in December 1991, and the last remaining offender is scheduled to cease dumping in June 1992. In order to end their ocean dumping, these sewerage authorities either have switched or will soon switch to beneficial re-use (recycling) of sludge or more costly sludge disposal methods, such as land disposal at permitted facilities or incineration, as a result of the Ocean Dumping Ban Act of 1988.

Cessation of Industrial Ocean Dumping. Between 1973 and 1987, the amount of U.S. industrial waste dumped in the ocean annually declined steadily from about six million tons to well under one million tons. Permitted ocean dumping of industrial wastes ceased in September 1988. Pollution traces from old sites can still be found in some areas, but the current impacts are considered minor or negligible. There are also prohibitions on disposal of high-level radioactive waste in ocean waters.

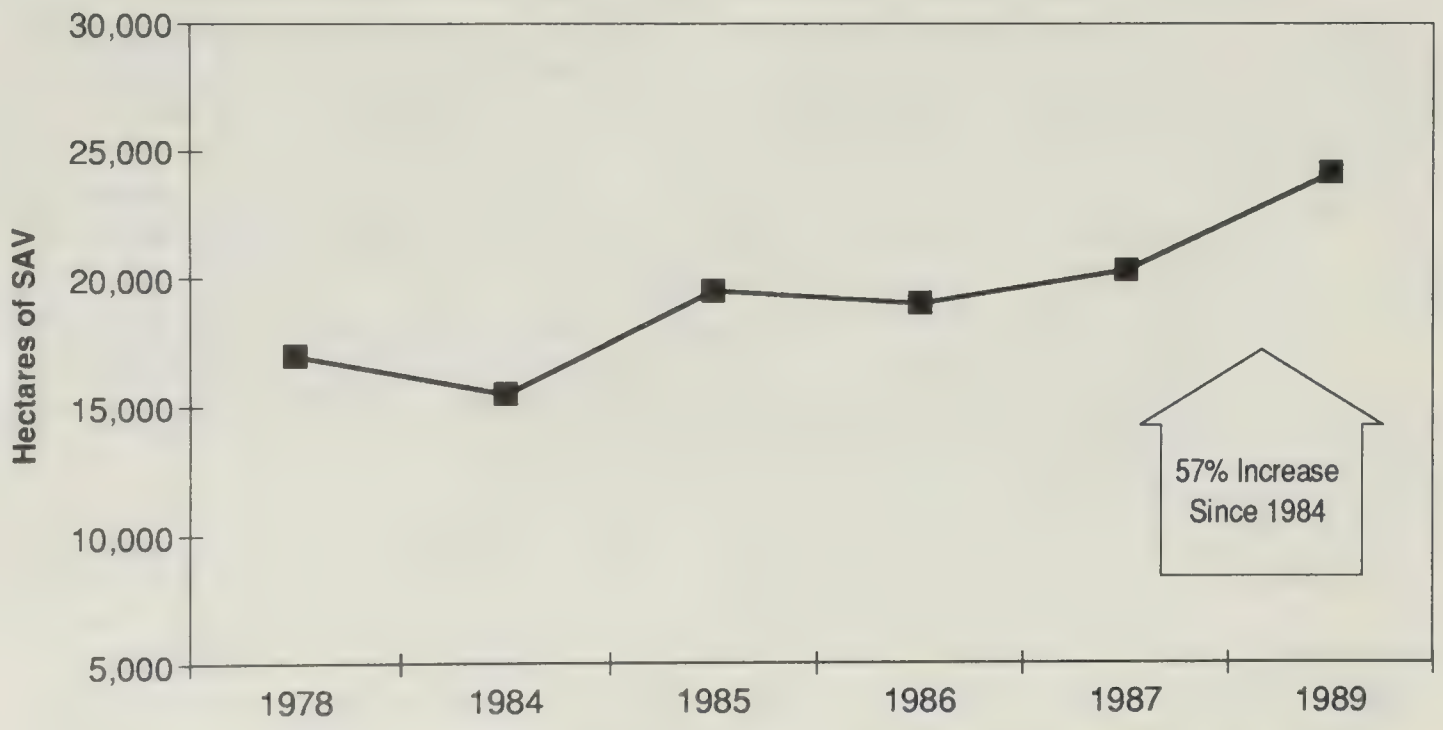
Chesapeake Bay Oyster Harvest Has Dropped Dramatically



Source: U.S. EPA, Office of Water, *National Water Quality Inventory: 1988 Report to Congress,* EPA 440-4-90-003, April 1990, p.65.

Exhibit 6d.5

Submerged Aquatic Vegetation Increasing Mid-Bay



Source: U.S. EPA, *The Chesapeake Bay ... A Progress Report,* August 1991, p.5.

Exhibit 6d.6

Endnotes:

1. The Magnuson Fishery Conservation and Management Act (MFCMA) defines the Exclusive Economic Zone (EEZ) as that region that extends 200 nautical miles seaward from the baseline from which the territorial sea is measured. The United States is responsible for wisely developing, managing and protecting the EEZ's environment and its living and non-living marine resources contained within.

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9. National Fish and Wildlife Foundation, *Needs Assessment of the National Marine Fisheries Service* (January 1990), 315pp.

10. U.S. Department of Agriculture, Economic Research Service, Aqua-6, *Aquaculture—Situation and Outlook Report*, March 1991.

11. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, *Fisheries of the United States, 1990. Current Fishery Statistics, no. 9000* (Silver Spring, MD: May 1991), 11pp.

12. Marine Mammal Commission, *Annual Report of the Marine Mammal Commission, Calendar Year 1990, A Report to Congress* (January 1991), 270pp.

13. Ibid.

14. National Academy of Science, National Research Council, *Decline of the Sea Turtles. Causes and Prevention* (National Academy Press: 1990), 259pp.

15. The Marine Protection, Research and Sanctuaries Act of 1972, Title III, authorizes the designation of certain areas of the marine environment which possess conservation, recreational, ecological, historical, research, educational or aesthetic qualities which should be conserved and managed as a marine sanctuary. It also authorizes study and designation of others.

16. The Coastal Zone Management Act of 1972 established the National Estuarine Research Reserves program which designates an area that is a representative estuarine ecosystem that is suitable for long-term research and designation. The designation of the area will serve to enhance public awareness and understanding of estuarine factors. Additional areas may be designated in the future.

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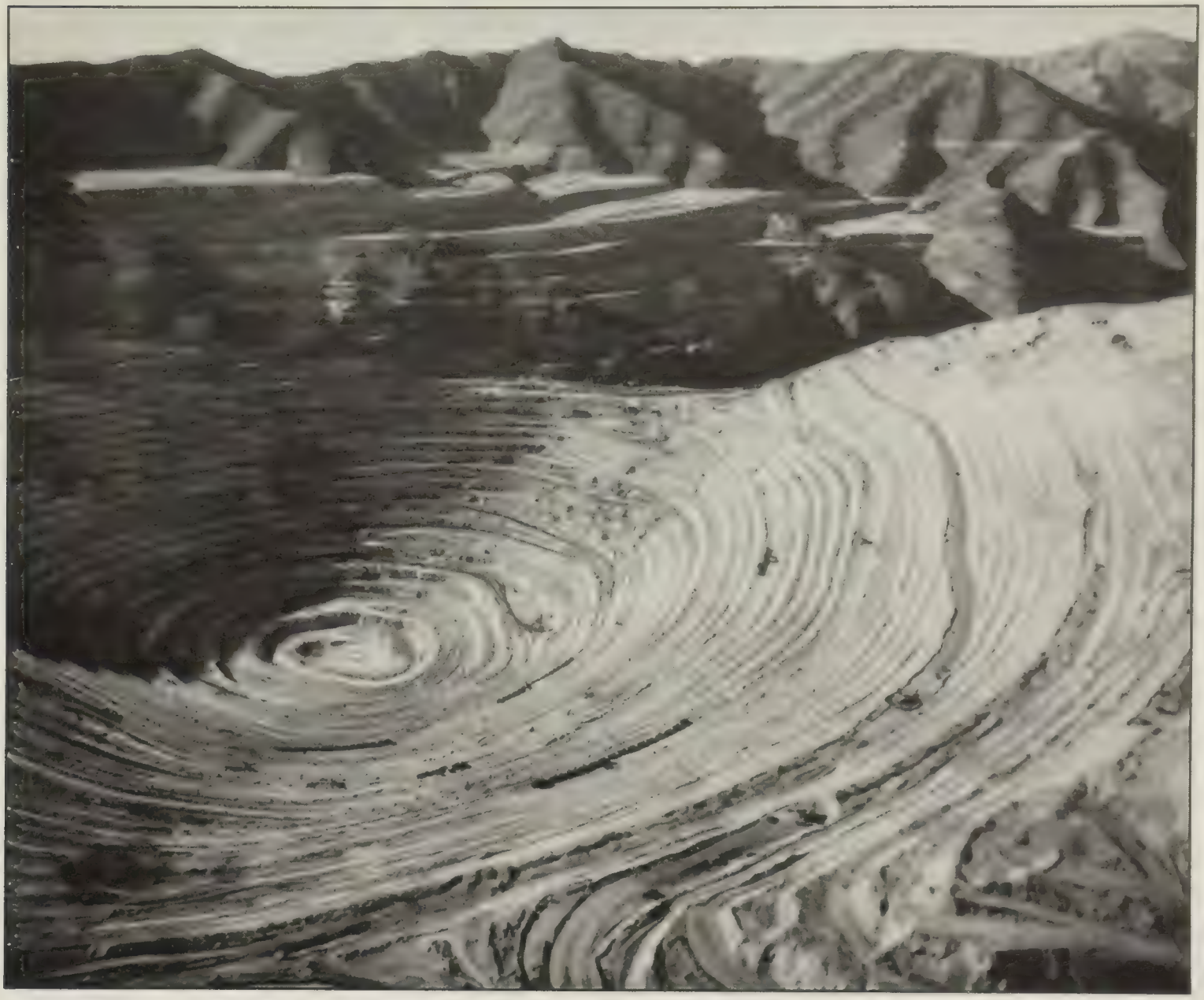
—E—
Land and Mineral Resources

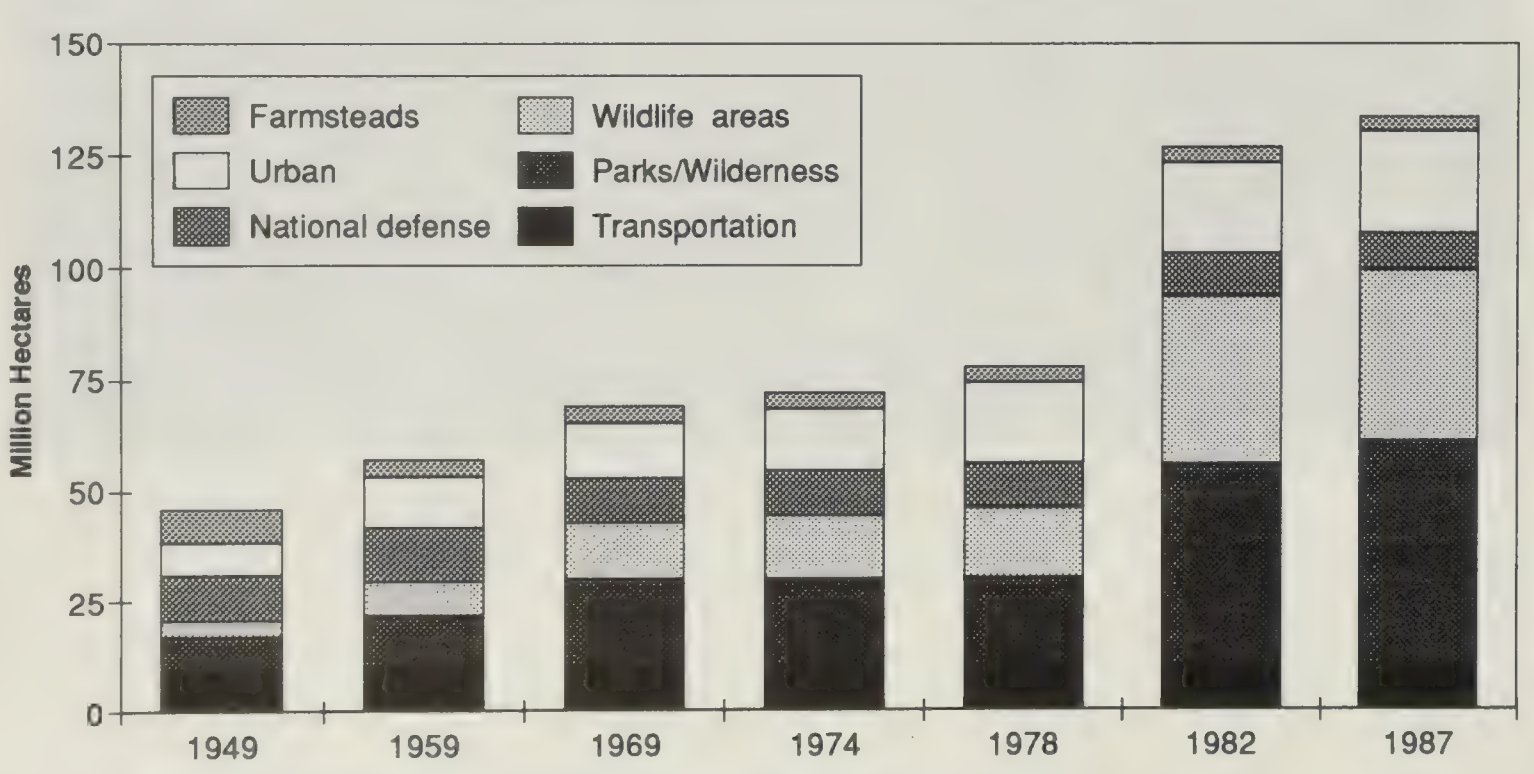


Overview

The total land area of the United States is slightly more than 900 million hectares. This land base encompasses a wide range of natural systems, including tropical and temperate forests, grasslands, desert and tundra. The principal categories of land use in the United States are forestland (29 percent), cropland (20 percent), grassland, pasture and range (26 percent), special land uses (15 percent), which include wildlife areas, parks, wilderness and urban lands, and other land uses (10 percent), which include marshes, desert and tundra.[1] The "special uses" land increased from six percent of the total land area in 1949 to 15 percent in 1987. Trends in these special uses of land are shown in Exhibit 6e.1.

Of the total U.S. land base, approximately 60 percent is in private ownership, including virtually all the nation's cropland, and the majority of it is grassland, pasture and range, and forestland. The federal government is responsible for the management of about 32 percent of the land area of the United States, much of which is within the states west of the Mississippi River. These lands are managed in accordance with various national laws by several federal agencies, described briefly below. The remaining eight percent of the U.S. land base consists of areas reserved for the American Indian nations, and lands managed by state and local governments for a variety of public purposes, including parks and recreation areas.[2]

"Special Uses" Land , 1949-1987



Source: Council on Environmental Quality, *1991 Annual Report*, Table 44.

Exhibit 6e.1

Public Land Resources

While some of the 290 million hectares of public lands now managed by the federal government were purchased from private owners, most are derived from the public domain lands that either were ceded to the federal government by the states after the Revolutionary War, or have been in federal ownership since they were acquired by purchase or treaty during the expansion of the U.S. frontier.[3] At first, the federal government sought to dispose of much of the public domain lands to encourage settlement and development of the western frontier. But during the latter half of the 19th century public interest grew in conserving some of the public forestlands for future use and in preserving places of natural or scenic beauty for public recreation. Eventually Congress established four federal agencies to manage the remaining public lands. The National Park Service and the Fish and Wildlife Service (both part of the Department of the Interior) manage lands protected by law for conservation and recreation purposes. The Bureau of Land Management (BLM), also part of the Department of the Interior, and the Forest Service, part of the Department of Agriculture, manage larger areas designated primarily for multiple-use activities, including timber and mineral production and livestock grazing, as well as recreation, wildlife habitat and watershed protection.

States, localities and the private sector also provide multiple-use lands. States administer approximately 25 million hectares of state parks and recreation areas, forests and wildlife areas. Municipal, county, and regional parks and forests which account for the largest number of recreation sites, cover a little over 3.5 million hectares. Private lands and facilities, such as campgrounds, ski areas, marinas and golf courses are an important part of the supply of outdoor resources. However, the extent of private recreation opportunities is unknown because the supply fluctuates, making comprehensive inventories difficult. National and local nonprofit organizations, such as the Nature Conservancy, the Audubon Society, and local environmental and historic preservation groups also make important contributions to protect important recreation and habitat lands.[4]

Federal Management of Public Lands

During the 20th century, the federal government has greatly increased the amount of land allocated to national forests, parks and wildlife refuges. This was accomplished in two principal ways. First, tracts of land from the public domain administered by the Bureau of Land Management have been designated by Congress as new or expanded national forests, parks and wildlife refuges, or added to existing ones. For example, in the state of Alaska during the last 20 years approximately 22 million hectares of BLM land were transferred to the Fish and Wildlife Service, 18 million hectares were transferred to the National Park Service, and approximately 1.2 million hectares were transferred to the U.S. Forest Service. In addition, 1.61 million hectares of public lands were designated for administration by BLM as conservation areas. These include the Steese National Conservation Area (approximately 400,000 hectares) and the White Mountains National Recreation Area (approximately 400,000 hectares), both in Alaska.

A second source for the expansion of forests, parks and refuges administered by all four federal land management agencies is acquisition by purchases of state or private lands. The primary funding source for these purchases has been the federal Land and Water Conservation Fund, established by law in 1965 to allow purchases of lands for conservation to be made from federal revenues generated by offshore oil and gas leasing, sales of excess federal property, and park and refuge entrance and user fees.

The Bureau of Land Management currently oversees 108 million hectares of public land, located mostly in the 11 western states and Alaska; the U.S. Fish and Wildlife Service (FWS) manages 471 National Wildlife Refuges and 28 Wetland Management Districts with waterfowl production areas in 161 counties for a system-wide total of approximately 37 million hectares. The National Park Service (NPS) is responsible for 32 million hectares of land encompassing 358 national parks, monuments, recreation areas and historic sites. The Forest Service (FS) manages 155 national forests, 19 national grasslands and 83 experimental forests and ranges, with a total area of 76 million hectares for timber and mineral production, grazing, recreation, wildlife habitat, research and other purposes. The mission and activities of each of these four agencies are summarized below.

Bureau of Land Management

The predecessor to the Bureau of Land Management was the General Land Office, which had as its primary mission the transfer of public domain lands to the private sector through such programs as the Homestead Act of 1862. Beginning in 1934 with the Taylor Grazing Act, the mission of the agency gradually shifted away from the disposal of lands to the management of lands for public purposes. This new mission was eventually made into law in the Federal Land Policy and Management Act of 1976 (FLPMA). This act defined the Bureau's mission to be multiple-use management, sustained yield and retention of the public lands in federal ownership. FLPMA also required BLM to undertake "an inventory of all public lands and their resources and other values" and to "develop, maintain, and, when appropriate, revise land use plans...for the use of the public lands."[5]

The Bureau of Land Management traditionally focused on certain economic uses of the lands, such as grazing, timber harvest and production of minerals and energy, including coal, oil and natural gas. In recent years, as the BLM carries out the planning and program changes required by FLPMA, its focus has been shifting toward a multiple-use approach which balances economic uses of natural resources with conservation and outdoor recreation, including management of fish and wildlife, wilderness, wetlands and riparian ecosystems. This shift is reflected in the bureau's budget requests as well as in recent planning efforts such as those reported in *Fish and Wildlife 2000*, *Recreation 2000*, and *Riparian-Wetlands Initiative for the 1990s*.[6] In addition, the Bureau of Land Management has received an increasing share of the Land and Water Conservation Fund budget for land acquisition in recent years.

In Alaska, the Bureau of Land Management still has a major legislated mission: land transfer. The Alaska Statehood Act, as amended by the Alaska National Interest Lands Conservation Act, granted almost 42 million hectares of federal lands to the state. The Alaska Native Claims Settlement Act granted Alaska Native corporations an additional 17.6 million hectares of land. The state is still in the process of selecting these lands from lands managed by the BLM.

Fish and Wildlife Service

The traditional Fish and Wildlife Service mission has been to conserve, protect and enhance fish and wildlife and their habitats for the continuing benefit of people. The backbone of the FWS's land management function is the National Wildlife Refuge System. The creation of national wildlife refuges began in 1903 when President Theodore Roosevelt designated Pelican Island, Florida, as a preserve and breeding ground for pelicans, herons and egrets. Most early refuges were public domain lands set aside as sanctuaries for colonial nesting birds or as game ranges intended to prevent extermination of native big-game animals. The first wildlife refuge specifically authorized by Congress was the Wichita Mountains Refuge in Oklahoma, established in 1905. Other big-game

areas followed; in 1924 the first waterfowl area was authorized and funded as the Upper Mississippi River Wildlife and Fish Refuge in the states of Minnesota, Wisconsin, Iowa, Illinois and Missouri.

In the years that followed, other public lands were withdrawn, areas were set aside for waterfowl production, and new refuges were established. The National Wildlife Refuge System was officially established in 1966 when Congress passed the National Wildlife Refuge System Administration Act and consolidated all refuge lands administered by FWS into a single national system.

Recent land acquisitions have been concentrated in areas subject to intense development on the East Coast, the Southeast and the West Coast. Federal land acquisition funds have come from the Land and Water Conservation Fund and from the Migratory Bird Conservation Account. In addition, the FWS has received donations of land to the refuge system from private companies, nonprofit organizations and citizens. These donations range from a few hectares to tracts of over 48,000 hectares. The FWS is authorized to accept such donations if they are of benefit to the system; it also has the option to sell donated tracts or exchange them for more suitable habitat.

While each refuge has one or more primary purposes for which it was established and around which its management is designed, all are operated with the overall mission of providing, preserving, restoring and managing a national network of lands and waters sufficient in size, diversity and location to meet society's needs for areas where a variety of benefits associated with wildlife and wildlands can be obtained. The FWS also has major responsibilities for protection of fish and wildlife resources on lands other than its own through such programs as the Endangered Species Act, providing consultations on water development and water quality projects under the Fish and Wildlife Coordination Act of 1934 and section 404 of the Clean Water Act, operating fish hatcheries, and providing grants to the states for activities that support conservation of fish and wildlife.

The Fish and Wildlife Service is currently undertaking a major examination of the refuge program through the preparation of a draft environmental impact statement on the management of the National Wildlife Refuge System through the year 2003. That date marks the 100th anniversary of the establishment of America's first national wildlife refuge in 1903. The plan and environmental impact statement, entitled *Refuges 2003*, will consider all reasonable alternatives and thoroughly analyze their environmental impacts. In developing this plan, the FWS is providing opportunities for public participation by all interested parties throughout the planning process.

National Park Service

The world's first national park, Yellowstone, was created in 1872 when Congress set aside more than 800,000 hectares of public domain lands as "a public park or pleasuring-ground for the benefit and enjoyment of the people." The legislation assigned the new park to the control of the secretary of the Interior, who would be responsible for issuing regulations to provide for the "preservation, from injury or spoilation, of all timber, mineral deposits, natural curiosities, or wonders within said park, and their retention in their natural condition."[7] Other park management functions included the development of visitor accommodations, the construction of roads and bridle trails, the removal of trespassers from the park and protection "against the wanton destruction of fish and game." From 1890 to 1915, Congress carved several more national parks from the public domain lands of the West, including Yosemite and Sequoia in California, Crater Lake in Oregon, Glacier in Montana and Rocky Mountain in Colorado.[8]

At the same time as interest was growing in preserving the great scenic wonders of the West, efforts were also underway to protect the sites and structures associated with early Native American culture, particularly in the Southwest. In 1906 the Antiquities Act authorized the President to "declare by public proclamation [as national monuments] historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest."[9] Grand Canyon and Petrified Forest National parks in Arizona, among others, were first set aside as national monuments under the Antiquities Act.

The National Park Service was created by statute in 1916; its organic act established as its mission to manage the national parks, monuments, and reservations " ...to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."[10]

Significant growth in the number and diversity of parks occurred as a result of a 1933 government reorganization, again following World War II, and again during the 1960s. In 1970, Congress formally recognized the collection of park units as a National Park System. (Each unit of the national park system, however, has its own particular purposes and objectives set forth in the legislation that established it.) The greatest single expansion of the National Park System took place in 1980, when the Alaska National Interest Lands Conservation Act added 17.4 million hectares to the system, including 10 new national parks and substantial additions to three others.[11] In recent years, there have been relatively few new units added to the system; land acquisition has been concentrated on completing of purchases of lands within established park boundaries.

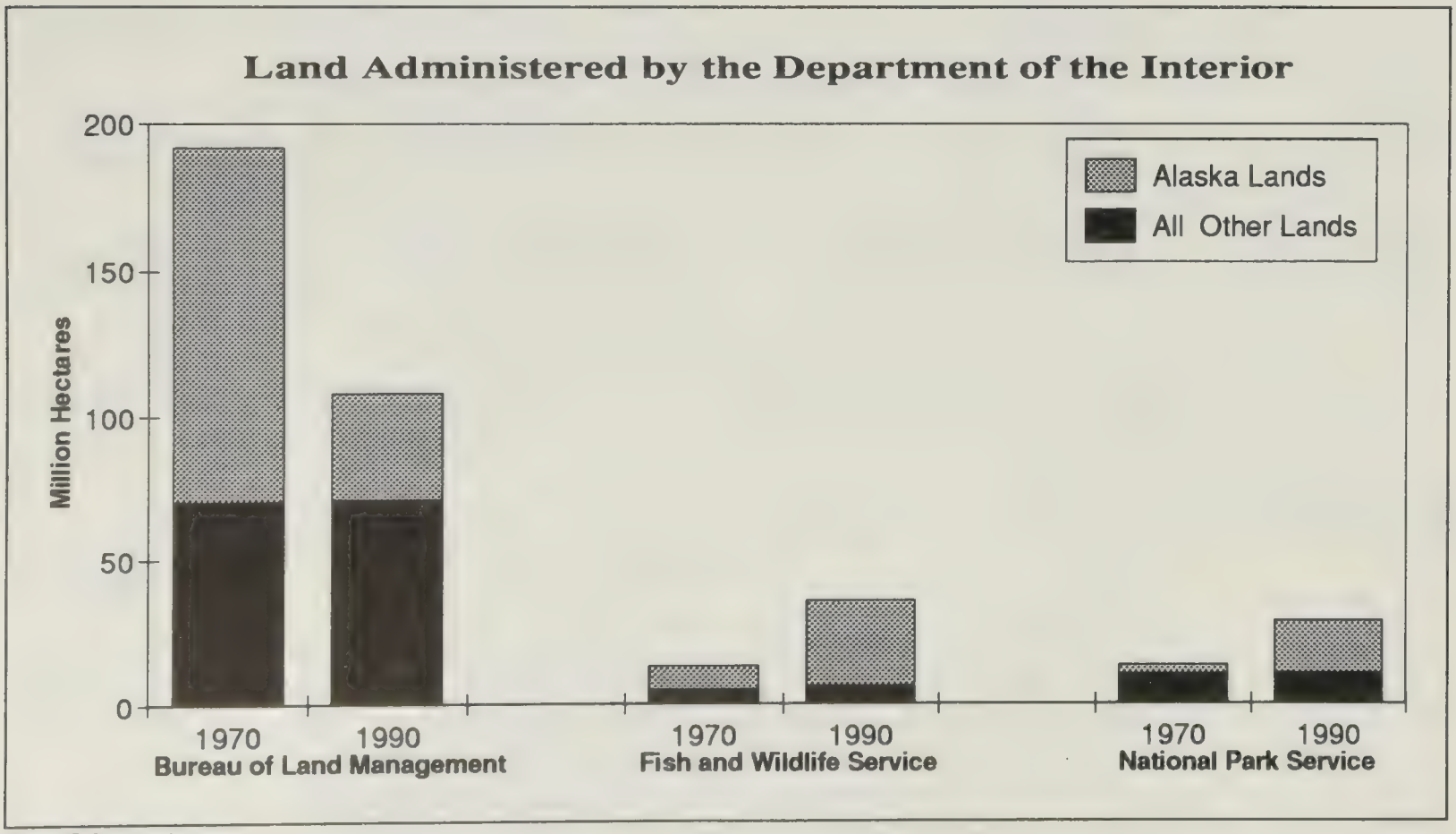


Exhibit 6e.2

Forest Service

The current National Forest System of 76.4 million hectares, or approximately 8.2 percent of the total U.S. land area, grew out of the forest reserves first established on the public lands in 1891. In response to uncontrolled clearing of public and private forest lands that resulted in soil erosion and flooding, Congress authorized the President to set aside forest reserves on the public lands to protect watersheds and assure a sustained yield of timber for the future. During the next 10 years, over 16 million hectares were reserved. Legislation passed in 1897 and 1905 established basic management policy for the forest reserves and transferred their jurisdiction to the Department of Agriculture. By the end of his term of office in 1909, President Theodore Roosevelt had used his authority to expand the forest reserves to a total of 76 million hectares. By then, Congress had revoked the President's authority to create forest reserves, but in 1911 it passed the Weeks Act, which authorized the purchase of private lands for national forests; eventually 9.2 million hectares of land in the East, primarily in the Appalachian Mountains, was acquired, primarily by purchase, and added to the National Forest System.[12]

Following World War II, growth in U.S. population and the economy fueled increased demands for both wood products and outdoor recreation opportunities. In 1960, to ensure that the national forests would be managed to meet varying demands, Congress passed the Multiple-Use Sustained-Yield Act, which declared that the national forests "shall be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes."[13] But conflicts in the use of forest resources resulted in the passage of the Resources Planning Act in 1974 and the National Forest Management Act in 1976, which set forth detailed requirements for national forest planning and management. These laws directed the Forest Service to produce land and resource management plans for each of the national forest and national grassland management units, and to regularly review and update these plans. The National Forest Management Act specifically places limitations on clearcutting, requires protection of riparian areas during timber harvesting, and states that management plans are to "provide for diversity of plant and animal communities."[14]

Through the National Forest System, the Forest Service currently provides a wide variety of natural resources, recreational activities and commodity outputs. Some of these are presented in Exhibit 6e.3.

In addition to direct management of the National Forest System, the Forest Service also conducts a nationwide cooperative forestry program with state forestry agencies, which assists state and private landowners in their efforts to manage almost 208 million hectares of state and private forestland. The Forest Service also conducts a comprehensive research program that includes studies of forest productivity, disease and pest control, wildlife management and forest ecology, among other subjects.

Issues in Public Land Management

The four principal federal land management agencies, as well as their state counterparts, face several challenges for the future. Among the issues shared by all are:

External Impacts. Air and water pollution from human activities, either adjacent to the public lands or transported from distant sources, have already had measurable effects on visibility, vegetation, fish and wildlife, and water quality in some national parks, forests and wildlife refuges. Some public lands have also been contaminated with hazardous wastes from external municipal and industrial sources, illegal dumping and drainage from mining. Because the regulatory authority of the federal public land agencies is restricted to activities within their management boundaries, they have begun to work cooperatively with other federal, state and local government agencies

National Forest System, Selected 1990 Statistics

Receipts	$1,688 million
Expenditures	$3,090 million
Number of Employees	43,013
Timber Harvested	47.25 million cubic meters
Reforestation	14.324 hectares
Grazing Permits Administered	10,527
Livestock Grazing	8.1 million animal unit months
Mineral Cases Processed	25,927
Recreation Use	263 million visitor days
Wilderness System	13.3 million hectares
Trail System	182,986 kilometers
Road System	581,000 kilometers
National Wild and Scenic Rivers System	5,390 kilometers
Watershed Improvements	12,153 hectares
Wildlife and Fish Habitat Improvements	70,763 hectares

Source: *Report of the Forest Service, Fiscal Year 1990*, USDA Forest Service, Washington, D.C. February 1991.

Exhibit 6e.3

to identify and monitor external sources of pollution and to assist in developing control strategies to be implemented by others.

The Navajo Generating Station (NGS), a large coal-fired electricity plant 24 kilometers from the Grand Canyon National Park boundary, was identified as one of the contributing sources of haze over the Grand Canyon in the winter months. An agreement between the federal government, environmentalists and owners of the plant to cut the annual sulfurous emissions by 90 percent by 1999 was signed in September 1991. EPA estimates that the cost to NGS of implementing measures to reduce emissions will be approximately $430 million and the total levelized annual costs (i.e., capital, operating and maintenance costs), measured in 1992 dollars, will be $89.6 million. For most of the utilities using NGS power, utility rates will rise less than three percent.[15]

The land management agencies are addressing hazardous waste problems in accordance with the Amendments to the Comprehensive Emergency Response, Compensation and Liability Act (CERCLA), inventorying, assessing, and removing or cleaning up hazardous materials and debris on federal lands. Surveys are also being conducted prior to land acquisition to ensure that lands are free of contaminants and debris at the time of purchase, donation or exchange.

Habitat Fragmentation. Habitat fragmentation refers to the breaking up of large units of contiguous or connected habitat into smaller, isolated segments. Often, this results in the loss of even those small tracts of similar habitat that allow animal species to move between habitats and that allow plant pollens to be dispersed. Habitat fragmentation is an issue primarily in forests where timber harvest and road development isolates timber stands, on farmland where small farms with traditional border rows of habitat have been replaced by large, contiguous farms with monoculture crops and "clean" borders, and on the urban/rural border area where houses replace farms and forests.

As a result of habitat fragmentation, the viability of some species becomes more dependent upon habitat remaining on the generally more extensive public land areas managed as parks, wildlife refuges, forests, wilderness, rangelands and recreation areas. Management of species affected by habitat fragmentation, such as the Northern spotted owl becomes increasingly difficult, especially when it conflicts with other traditional uses.

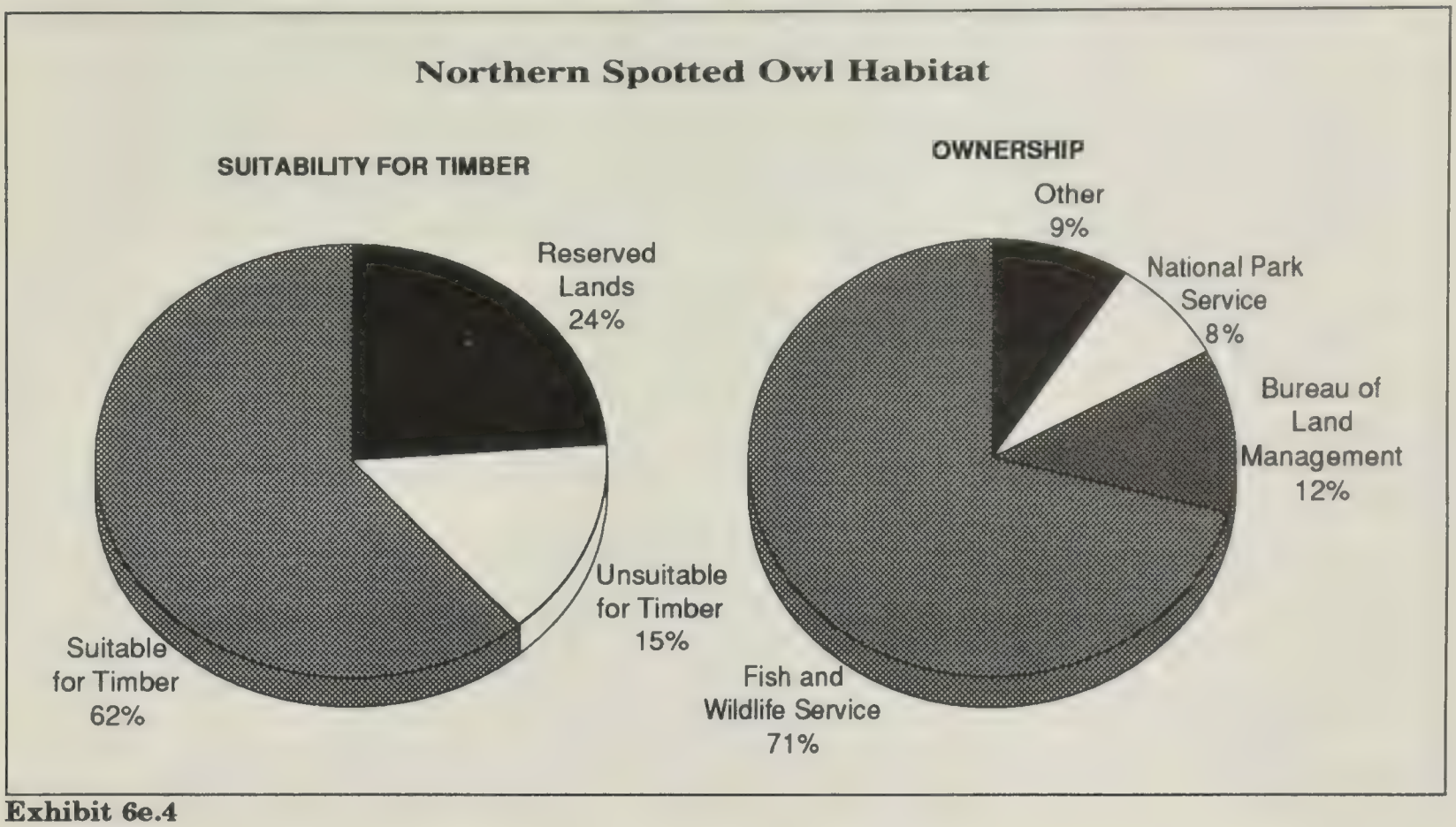


Exhibit 6e.4

Managing for Increased Recreation Usage. Increased mobility and leisure time have resulted in increased tourism for all public lands, particularly the National Parks. Approximately 259 million recreation visits were made to the National Park system's 358 units (32 million hectares) in 1990.[16] In 1971, the earliest year for which statistics are available, 154 million recreation visits were made to 12 million hectares. Continued expansion cannot solve the seasonal or site-specific crowding that sometimes occurs. Yellowstone National Park (Wyoming) and Yosemite National Park (California), for example, will likely always be among the nation's favorites, and summer months are likely to remain the most popular visitation times. Entrance to the National Parks is generally not subject to specified capacity limits. However, to avoid overcrowding and natural resource degradation, some rivers and backcountry areas are restricted to permit holders.

The National Park Service, in conjunction with private and public organizations has introduced several measures to mitigate the potential human impacts of increased visitation. To reduce traffic and parking problems, the National Park Service operates visitor transportation systems in 12 areas. Transportation services are also provided by concessionaires and others outside of the other parks. These transportation systems improve visitor safety and enjoyment. They minimize visitor impacts on fragile natural resources and help avoid costly improvements to roads and parking areas which would be required to safely accommodate heavy automobile use.

CASE STUDY

NORTHERN SPOTTED OWL

The Pacific Northwest

One well-known example of the conflict between traditional uses of forests and management of species affected by habitat fragmentation involves the Northern spotted owl, which was listed as a threatened species in 1990. The owl's preferred habitat is ''old growth'' forests in the Pacific Northwest. These forests now occur primarily on federal lands managed by the U.S. Forest Service and the Bureau of Land Management. These lands have been a major source of prime timber, employment, and federal and local revenues associated with timbering for many years. Consequently, the conflict between the needs of the owl and other old-growth dependent species, and those of timber workers and timber-dependent communities has focused attention on the choices involved in public land management, as well as the costs and benefits of environmental protection.

The Northern spotted owl of British Columbia (Canada), Washington, Oregon and Northern California nests primarily in dense, mature and old-growth forests, commonly dominated by Douglas-fir trees, although a number of other forest types and some younger age stands are also used for other life cycle activities such as foraging and nesting. Mature and old-growth forests contain the structural characteristics and vegetation type that best provide spotted owls with food, cover, nesting sites, and protection from weather and predation.

The amount of suitable habitat for spotted owls is estimated to have declined by 60 percent since 1800 (7 million hectares in 1800 to almost 3 million hectares today). Following World War II, timber companies began to look to federal lands to satisfy increasing timber demands. The harvesting of old-growth timber on public and private lands has led to the progressive loss of spotted owl habitat. Old-growth forests preserved in reserved public lands amount to more than 600,000 hectares of owl habitat (See Exhibit 6e.4.)

Public demands for preservation of old-growth forests have increased since the 1970s. Beginning in 1973, and continuing through the 1980s, biologists from government agencies, universities and private groups developed and refined guidelines for managing spotted owl habitat. There are other species, besides the spotted owl, that depend on old-growth habitat. The spotted owl controversy is thus in some ways only the driving force in a broader controversy over management of Pacific Northwest old-growth forests.

The viability of spotted owl populations appears to depend on the total amount and distribution of suitable habitat sufficient for a relatively high number of breeding pairs over a broad geographic area that provides for interaction and movement of individuals throughout the population. As the amount of habitat declines, it often becomes more fragmented. If suitable habitats become too distant from one another, movement of owls from one habitat to another becomes increasingly difficult. Then, the likelihood increases that parts of the owl population will become isolated. The current Northern spotted owl population is estimated to be approximately 2,400 pairs.

Federal Actions

- On July 23, 1990, the U.S. Fish and Wildlife Service listed the Northern Spotted Owl as a threatened species under the Endangered Species Act.

- On February 5, 1991, Secretary of the Interior Manuel Lujan announced the formation of a team to prepare a recovery plan that will recommend action to bring the owl to the point at which it will no longer need the protection of the act. A draft plan is scheduled to be issued for public comment by spring 1992, and the final plan is expected later in 1992.

- On June 17, 1991, the U.S. Fish and Wildlife Service issued biological opinions to the Bureau of Land Management, concluding that 44 timber sales proposed for its 1991 timber sales program in Oregon are likely to jeopardize the continued existence of the spotted owl.

- On September 11, 1991, the director of the Bureau of Land Management submitted an application to Secretary of the Interior Lujan seeking an exemption from the requirements of the Endangered Species Act for the 44 proposed timber sales. On October 1, Secretary Lujan agreed to convene the Endangered Species Committee (ESC) to consider the application. The ESC consists of the secretary of the Interior (Chairman), the secretary of Agriculture, the secretary of the Army, the administrator of the National Oceanic and Atmospheric Administration, the administrator of the Environmental Protection Agency, the chairman of the Council of Economic Advisors, and a resident from the affected state, nominated by the governor and appointed by the President. Under conditions specified in the Endangered Species Act, the ESC is empowered to grant exemptions from the provisions of the act if the Committee finds that:

- There are no reasonable and prudent alternatives to the agency action;

- The benefits of such action clearly outweigh the benefits of alternative courses of action consistent with conserving the species or its critical habitat, and such action is in the public interest;

- The action is of regional or national significance; and,

- It establishes such reasonable mitigation and enhancement measures, including but not limited to, live propagation, transplantation, and habitat acquisition and improvement, as are necessary and appropriate to minimize the adverse effects of the agency action upon the endangered or threatened species or critical habitat.

The National Park Service, the Dow Chemical Company and Huntsman Chemical Corporation formed a partnership in the spring of 1990 to recycle plastic, glass and aluminum in three national parks. More than eight million park visitors participated in the program during the first summer and fall seasons, recycling over 77,000 kilos (about 86 tons) of plastic, glass and aluminum. The program expanded in 1991 to include two additional parks, with further expansion under study. The program serves not only to improve solid waste management, but also to provide millions of park visitors with information encouraging recycling.

Public land management requires partnerships between public and private agencies to maximize the effectiveness of federal funds and to encourage private-sector involvement in preserving natural and cultural resources. Such cooperative efforts have served to protect Civil War battlefields and restore the Statue of Liberty/Ellis Island in New York Harbor and Mount Rushmore in South Dakota. These partnerships will continue to support public land managers as they expand recreational opportunities beyond the National Parks to other public lands. For example, in 1991 the secretary of the Interior, initiated the "Enjoy Outdoors America" program to expand and enhance outdoor activities on all Department of the Interior lands.[17] The program focuses primarily, but not exclusively, on eight major activities: fishing, hiking, scenic touring, camping, boating, bicycling, winter sports and hunting. In fiscal year 1991, 307 "Challenge Cost Share" projects to benefit fish, wildlife and special status plants were initiated on public lands managed by the Bureau of Land Management.[18]

Private Land Resources

This section briefly reviews the size, uses and productivity of privately owned croplands, forestlands and pasture lands in the United States. For agricultural lands, soil erosion is a special concern; further information about agriculture and the environment is found in Chapter 4. Nonfuel mineral resources are also briefly discussed here. Additional perspectives on U.S. lands as ecosystems, and a discussion of plant and animal species and their habitats are presented, in the "Plants, Animals, and Biodiversity" section of this chapter.

Croplands

The United States contains some of the most productive croplands in the world. These lands provide food and fiber, not only to U.S. citizens, but also to many other countries. Through research and development and application of technology, the productivity of U.S. croplands has increased markedly in the past two decades.

Area of Croplands. Despite continued growth in the U.S. population, the area of land classed as cropland has remained relatively stable since 1930. The suitability of land for crops depends on the combined effects of soils, climate, topography, water availability and patterns of human settlement. Although several million hectares of cropland were converted to other uses, usually either to urban development or to forestry, during the past 20 years, about the same amount has been added to the cropland base because of conversion of forestland or rangeland to cropland. At the margin, the balance of hectares in cropland, range or forest use is dynamic.[19] However, conversions to urban use are usually irreversible. Depending on relative market conditions for agricultural and forestry products and on government programs, cropland converted to forestry may again be put into cropland use. In general, however, forestry is the residual land use. Gains in cropland area

have also occurred, generally through conversion of forest and rangelands, and to a lesser extent, by draining wetlands. As is discussed elsewhere in this report, draining of wetlands is now being discouraged as a matter of national policy. The section on agriculture in Chapter 4 provides additional information on croplands.

Forestlands

Forestlands in the United States perform multiple functions, both economic and environmental. As natural ecosystems, they contribute substantially to the nation's biodiversity and remove large amounts of carbon dioxide from the atmosphere; as habitat for fish and wildlife, and as places of scenic beauty, they provide outdoor recreation; as soil-conserving watersheds, they help to ensure supplies of high-quality water, especially in the West. Forestlands yield much of the structural and decorative building materials used in housing and furniture, and are the source of most of the fiber for the manufacture of paper and paperboard.

The market commodities from forestlands are important to the U.S. economy, but use of forestland for non-commodity purposes has been growing faster than use for commodity production. Although trees take decades to reach marketable sizes, timber growth since 1952 has exceeded harvests. Less than one percent of the nation's timberland is harvested each year. During the last 20 years, growth in various non-commodity uses of forestlands, particularly in uses such as recreation, wilderness and wildlife habitat reserves, has led to some conflicts among users similar to the issues discussed above with regard to public lands.

Area of Forestland. Forests occupy close to one-third (292 million hectares) of the total U.S. land area. Two-thirds (193 million hectares) of U.S. forestland is classified as timberland—i.e., forestland capable of producing roughly 1.5 cubic meters per hectare of industrial wood annually and not otherwise reserved from timber harvest. An additional 14 million hectares of forestland meet the productivity requirements for classification as timberland, but have been reserved for non-timber uses and, as stated above, are managed by public agencies as parks or wilderness areas. The remaining forestland—some 86 million hectares—is not considered productive timberland because of adverse site conditions such as sterile soils, dry climate, poor drainage, high elevation, steepness or rockiness. This land nevertheless provides wildlife habitat and recreational opportunities, and has other non-commodity values.[20]

Available information on changes in forestland area generally shows net changes only. Over any period of measurement, some land areas are converted to forestland and from forestland to other uses. Conversion may be natural, such as through abandonment of cropland, or it may be human-caused, such as deliberate forestation of pasture land. At the national level, annual changes in forestland area are relatively small; between 1970 and the early 1980s, U.S. forestland area declined three percent. Most of the decline between 1977 and the early 1980s occurred on the Pacific coast and in the South. Since the early 1980s, the decline in forestland area has slowed and levelled, and it may be rising under current forest and agricultural policies. Indicative of the productivity and health of this forestland is its increase in total biomass of 1.87 percent between 1977 and 1987. The significance of this productive performance for timber production is further discussed below.[21]

Timberlands. The timberlands of the United States span a wide range of latitudes, elevations, precipitation and soils and as a consequence, are composed of diverse tree species. The types of forests differ in their susceptibility to fire, insects and disease. They also differ in ownership, in response to forest management techniques, growth rates and end products manufactured from timber harvested in them. U.S. timberlands contain 23.2 thousand-million cubic meters of timber, of which 91 percent is in growing stock—live, sound trees suited for roundwood products such as sawlogs and pulpwood. Some 60 percent of the growing-stock volume is in softwood species.[22]

Timber volume on timberland increased five percent between 1970 and 1977 and four percent between 1977 and 1987, despite a loss in timberland area. Between 1970 and 1986, net annual growth of timber on timberland increased 14 percent to 630 million cubic meters, while the timber harvest on timberland increased 22 percent to 460 million cubic meters. Approximately 80 percent of the total timber harvested in the United States comes from private lands; the remaining 20 percent comes from the national forests and other public lands. By most measures, productivity of timberlands has been increasing, especially for softwoods. For example, the annual growth per hectare of softwoods increased 18 percent between 1970 and 1987. In part, this reflects management inputs over the past several decades. The United States grows more wood than it harvests. The ratio of growth to harvest in 1986 was 1.37 for all species, 1.13 for softwoods, and 1.9 for hardwoods. In 1970, comparable data were 1.4 for all species, 1.2 for softwoods, and 1.8 for hardwoods.[23]

As described above, in addition to timber production U.S. forestlands are increasingly valued for their contributions to biodiversity, recreation, wildlife and fish habitat, water, range forage, air quality and minerals. Managing public and private forests to respond to these growing demands is a challenge. Further discussion of key forest management issues is found in the section of Chapter 6 entitled "Plants, Animals and Biodiversity."

Grasslands, Pasture and Range[24]

Prior to European settlement of North America, the continent's grasslands supported large populations of grazing animals such as bison, antelope, elk and deer, which were hunted as game by Native American societies. During the 19th century, intensive hunting plus the introduction of domestic livestock led to drastic declines in grassland game-animal populations, in some cases almost to extinction. Throughout this century, the principal commercial use in the United States of what were formerly native grasslands has been as pasture and range for grazing of domestic livestock, primarily cattle and sheep. Other uses of these lands are growing in importance, while per capita demand for red meat has remained relatively stable in recent years. Meanwhile, long-term recovery programs for several endangered species dependent on these lands, coupled with the establishment of additional parks and habitat preserves, have had considerable success. Populations of most big-game species are now more secure, more widely distributed and more abundant than they were at the turn of the century.[25]

Increasingly, however, there are conflicts between the use of range by wild horses and big game, such as elk, and its use for domestic livestock. The open spaces and other unique properties of public rangelands are attracting a growing number of recreational users. The challenge for federal land management agencies is to satisfy the mix of demands for this land, including forage for domestic and wild animals; maintenance of air quality and water quality and quantity; protection of open space, scenic quality and recreation; and improvements in plant diversity and biological community stability.

Area of Grasslands. All pasture and range in the United States accounted for about 324 million hectares in 1987. The total area of pasture and range has declined 12 percent between 1964 and 1987.[26] Pasture and rangelands with limited water resources or with high soil erosion potential have been converted to cropland when demand for crops was high. In other areas, without management, pasture land has reverted to forest, especially in the South. There is also continual and irreversible loss of pasture and rangelands to urbanization. Forage from grazing pasture and range must compete with other sources of feed for domestic livestock.

Some of the net decrease in range in the western United States involved federal lands that were withdrawn for parks, wilderness and similar uses, or were reclassified as unsuitable for grazing; ecologically, these lands remain grasslands. Among reasons for the decline in forested grazing land are fewer farms and less land in farms, changes in forest species, increases in stand density, and improvements in both livestock feeding and forest management practices.

Productivity. In general, slightly more than half of U.S. pasture and range is classified in early (poor) or mid-seral (fair) quality, which represents poor to fair nutritional value for livestock grazing.[27] Early or mid-seral sites usually provide less high-quality forage, wildlife habitat and watershed protection than sites in late seral or potentially natural condition. Sites in late seral or potentially natural condition are also less likely to be prone to erosion problems. Site condition can be improved through proper vegetation management, and by controlling the duration, seasonal timing and intensity of livestock use.

Several studies have found that range condition has gradually improved over the past several decades; however, range improvement requires long-term planning and management, as well as patience, given the limited precipitation, temperature extremes and frequently short growing seasons that characterize semi-arid environments in the Western United States. In many Western plant communities, progress to the next seral stage can take decades, even under proper management. Accordingly, federal land management agencies have set long-term goals and plans for range improvements, focusing first on sensitive range environments such as those in riparian zones.

Other Uses of Pasture and Range. In addition to forage production, pasture and rangelands often contain habitat for many species of wildlife, offer wide vistas and scenic attractions, and provide opportunities for recreational activities. Multiple-use management of pasture and rangeland offers many challenges and opportunities. For example, the resurgence of big-game populations in the West has caused conflicts with domestic livestock in some localities.

Issues in Erosion

In recent years, soil erosion has emerged as a key issue in evaluating the quality and productivity of land resources. In 1977, sheet and rill erosion resulted in the loss of 3.5 thousand-million tons of soil from non-federal lands in the continental United States. By 1982, that rate had been reduced to 1.8 thousand-million tons per year, and by 1986, to 1.6 thousand-million tons. In a more recent estimate, actions taken by U.S. farmers under land protection provisions of the 1985 Farm Bill have succeeded in reducing soil erosion still further.[28]

Quantifying the damage to crop production from erosion is difficult. Erosion reduces yields when it is severe. Generally, however, only a very small amount of soil is moved in any one year. The resulting annual loss in

productivity is so small that it is hidden by differences in the weather or in the management practices farmers apply from year to year. The USDA Soil Conservation Service estimated that, under management practices in use in 1982, sheet, rill and wind erosion would reduce productivity on croplands nationally by 2.3 percent in 100 years. The loss in productivity due to sheet and rill erosion is estimated to have a value of $6.2 thousand-million over the 100-year period.

However, the consequences of soil loss from erosion are more than just depletion of topsoil. Soil washing off cropland, pasture or forestland ends up in surface water, in the air and on other lands. Sediment in surface water causes turbidity, siltation and deterioration of aquatic habitats, decreases water storage capacity in lakes and reservoirs, and clogs water distribution systems. Eroded sediments can carry fertilizers, pesticides and salts that reduce water quality and present potential health hazards. Soil particles blown by wind can cause dust storms that physically damage crops, buildings and equipment, and permeate homes, offices and factories with dust. Windblown particles can also harm air quality, exacerbating respiratory ailments and impairing vision in humans and other animals. Cost estimates of the damage done by water erosion include $2.1 to $10 thousand-million annually in health and welfare losses, plus $1.1 to $3.1 thousand-million per year in damage caused by sediments; and $3 per ton for off-site damages resulting from wind erosion.

Through continued application of conservation practices, erosion can be reduced further in the United States. Except in severe situations, such as when topsoil has been eroded to bedrock, soil productivity can be restored through conservation practices and careful application of fertilizers and soil conditioners. Restoration can be costly; thus there is a growing emphasis in the United States on prevention of erosion and on the use of techniques for sustainable resource management. Erosion and erosion control and prevention measures are discussed in Chapter 4.

Nonfuel Mineral Resources

Nonfuel minerals, which include metal ores, fertilizer and chemical minerals, building stone, sand and gravel, and other resources, are essential for construction, toolmaking, machinery, transportation, agriculture and nearly every other industrial activity. The development of some of the most sophisticated new technologies, such as high speed computers and superconductors, would not be possible without nonfuel minerals.

Overall, foreign sources supply about 25 percent of nonfuel minerals to the United States (40 percent of unprocessed metals, and 12 percent of fertilizer and chemical materials requirements). While the United States relies heavily on imports of platinum-group metals, chromium, cobalt and manganese, the nation is fairly self-sufficient in construction, fertilizer and chemical minerals, and is a net exporter of phosphate rock and molybdenum.[29]

The United States possesses significant reserves of many nonfuel minerals such as copper and iron ore. Although estimated reserves of copper, lead and phosphate rock have declined during the past 20 years, domestic reserves of other nonfuel minerals such as gold and iron ore have increased, due in part to the discovery of new deposits and in part to the development of new technologies that have allowed recovery of resources previously considered uneconomic. Examples of technologies that have been partially responsible for increases in reserve levels are the refinement of the cyanide leaching process for extracting gold and the solvent-extraction electrowinning

technology that produces copper by leaching low-grade oxide ores. In addition, recently developed technology now allows iron ore to be recovered from domestic reserves previously considered not economically recoverable.

Although Alaska remains largely unexplored for nonfuel minerals, geological evidence indicates the potential for mineral deposits of major economic significance. Nearly 300 sites throughout Alaska and the adjoining continental shelf have been, or continue to be, under investigation for chromium, cobalt, platinum-group metals, tin, tungsten, zinc, lead, gold, copper and other mineral resources. Red Dog, in northwest Alaska, contains the world's second largest zinc deposit.[30]

Crushed stone and sand and gravel—industrial minerals used in construction—are prevalent throughout the United States; sand and gravel production takes place in all 50 states and the Atlantic and Pacific insular areas. Local shortages that occasionally occur are often the result of urban development or zoning regulations that lead to closure of operating quarries or prevent development of new operations rather than a lack of stone or sand and gravel.[31]

In current U.S. dollars, the total value of domestic nonfuel mineral production increased from $24 thousand-million in 1979 to $32 thousand-million in 1989, with metals accounting for about $12 thousand-million of the total.[32] Other industrial minerals account for the remainder.

Issues in Mineral Resources

Land Reclamation. Approximately half of the U.S. land area altered by mining activities between 1930 and 1980 has been restored to some degree.[33] Some lands have been reclaimed or converted to other economic uses, such as farming, grazing, highways, recreation areas or industrial and residential complexes, while other lands have been returned to their natural state. Reclamation of private lands mined for nonfuel minerals is not explicitly required by federal laws; however, the Clean Water, Clean Air, and Resource Conservation and Recovery Acts include requirements that serve to encourage reclamation of mined lands. Under most state laws, prior to commencing work, mining companies must post a bond or provide other financial guarantees sufficient to ensure that land reclamation will be done. State and federal demonstration projects have shown the effectiveness of environmentally sensitive mine design and modern reclamation practices. In addition, state programs are reclaiming abandoned nonfuel mine sites, using federal funds collected from miners of coal and other fuel minerals.

Land Withdrawals and Environmental Protection. Congressional efforts to protect lands with special wilderness, recreational or other natural values have produced protected lands legislation such as the Wilderness Act and the Alaska National Interest Lands Conservation Act. These acts restrict or constrain pre-existing mineral development and prohibit subsequent acquisition of mineral title (or rights) by private individuals on designated federal lands. For example, by the end of 1989, nearly 14 million hectares of U.S. national forest and Bureau of Land Management lands had been designated by Congress as wilderness.

Government policies to protect or improve environmental quality have also affected U.S. mineral production and reserve levels. Regulatory compliance costs incurred by some sectors of the domestic minerals industry have contributed in the short term to higher production costs, a reduction in capital availability, and lower production and reserve levels. One government study estimated that, as a result of regulatory costs associated with the Clean Air and the Clean Water acts, the mining industry invested $5.5 thousand-million in pollution abatement facilities and equipment from 1973 to 1979—more than 12 percent of the combined total spending by all industries

CASE STUDY

ALASKA'S RED DOG MINE

The State of Alaska

The recent opening of Alaska's Red Dog Mine provides an example of how a native for-profit corporation and a responsible, major international private minerals company, working closely with the local population, the environmental community and state agencies, can successfully achieve the agreements necessary to open a mine in remote Alaska.

The Red Dog Creek Zinc Deposit, 80 kilometers from the Arctic northwest coast of Alaska, was first explored by mining companies in 1978. Its zinc reserves are the second largest in the world. Red Dog's proven reserves contain about two-thirds of all U.S. zinc reserves. In seeking to develop this deposit, however, the native corporation owning the minerals and its partner minerals company faced many of the obstacles that have made mining more difficult in Alaska than is popularly supposed. The deposits are just outside the boundaries of a national park unit. The 80-kilometer overland route to a port site on the coast lay through the Cape Krusenstern National Monument. The Northwest Alaska Native Association (NANA) Regional Corporation, one of the 13 Alaska Native regional corporations, negotiated with the federal government to allow an access route through the monument.

In 1979, NANA shareholders approved mineral development of the region, subject to three stipulations: protection of maximum employment for the shareholders; adherence to strict environmental controls, including the right to shut down any or all parts of the operation that threatened subsistence habitats; and a guarantee of an adequate cash return to NANA.

In 1980, NANA's selection rights were ratified by Congress, and NANA began considering joint-venture opportunities with the companies that had been exploring the region. The winner was Cominco, a company based in Vancouver, Canada, the largest zinc and lead producer in western North America, which had substantial Arctic mining experience, and had a proven policy of hiring local Native residents as workers in its Canadian mining operations.

Under the joint-venture agreement negotiated with NANA, Cominco is to have an all-Alaska Native work force by the 12th year of operation. Annual production will be capped at a rate that guarantees at least 50 years of production. Development and production will abide by environmental protection decisions made by a committee of Inupiat elders (representatives of the Alaska Native residents of the area). A royalty package was worked out that gives some up-front royalties but reserves the major portion of the royalties for later years.

The alliance with NANA was a major factor in meeting some other environmental concerns. NANA elders worked out a 83-kilometer corridor through the Cape Krusenstern National Monument that carefully avoided environmentally sensitive sites or mitigated impacts. This route received the endorsement of some environmental groups, and in 1985 Congress approved an easement for the corridor, giving it to NANA in an exchange for other NANA lands coming to the federal government. Meanwhile, Cominco, with NANA's support, successfully persuaded the Alaska state government to invest in the transportation infrastructure necessary for operation of the mine by promising payment of 50 years of guaranteed toll fees for the use of the road. The fees serve as a guarantee of payment of development bonds sold by the state of Alaska.

With the major hurdles cleared, the mine that many industry experts had once considered an impossibility was finally constructed in the late 1980s. In 1990, the mine went into partial production; in 1991 it reached full production. More importantly, the Red Dog development may have shown others a way to undertake environmentally compatible development of Alaska's mineral resources.

for this purpose.[34] More recently, the American Mining Congress, an industry association, estimated that between 1973 and 1990 the domestic minerals-processing industry spent over $12 thousand-million on pollution controls.[35] A major challenge facing the mining industry is maintaining its economic profitability while also meeting the more stringent health and environmental quality objectives sought by society at large and expressed in law and policies by federal and state governments.

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3. U.S. Department of the Interior, Bureau of Land Management, *Public Land Statistics, 1989* (Washington, D.C.: U.S. Government Printing Office, March 1990).
4. President's Commission on Americans Outdoors, *Report and Recommendations to the President of the United States* (Washington, D.C.: U.S. Government Printing Office, December 1986), pp. 41-43.
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8. Council on Environmental Quality, Executive Office of the President, *Environmental Quality: the Third Annual Report of the Council on Environmental Quality* (Washington, D.C.: U.S. Government Printing Office, 1972), p. 315.
9. The Antiquities Act of 1906 (16 USC 431-33).
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19. Arthur B. Daugherty, *Major Uses of Land in the United States*, AER-643 (Washington, D.C.: U.S. Department of Agriculture, Economic Research Service, 1991).

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21. Noel D. Cost, J.O. Howard, B. Mead, W.H. McWilliams, W.B. Smith, D.D. Ban Hooser and E.H. Wharton "The Forest Biomass of the United States," *General Technical Report* WO-57 (Washington, D.C.: U.S. Department of Agriculture Forest Service, 1990): p. 21.

22. Waddell, et. al. 1989. See note 6.

23. Waddell, et al., 1989. See note 6.

24. The term "grasslands, pasture and range" has been in use for a long time. Grasslands are naturally occurring ecosystems dominated by value grasses; pasture and range are lands used for grazing livestock, including natural grasslands, cleared forest, and other managed lands. Some pasture occurs naturally, mainly in the eastern United States. Improved rangeland can be designated as pasture, whereas range generally refers to the large expanses of open grassland in the West.

25. U.S. Department of Agriculture, Forest Service, *RPA Assessment of the Forest and Rangeland Situation in the United States*, Forest Resource Report No. 26 (Washington, D.C.: 1989), p. 72.

26. Daugherty, et. al. 1991. See note 3.

27. U.S. Department of the Interior, Bureau of Land Management, "State of the Public Rangelands" (Washington, D.C.: March 1990) Unpaginated.

28. Further information on and discussion of these soil erosion problems can be found in U.S. Department of Agriculture, Soil Conservation Service, *The Second RCA Appraisal*. (Washington, D.C.: 1989): p. 280.

29. U.S. Department of the Interior, Bureau of Mines, *Mineral Commodity Summaries* (Washington, D.C.: 1990), 199 pp.

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PLANTS, ANIMALS AND BIODIVERSITY

Overview

Biodiversity, or biological diversity, is an inclusive or "umbrella" term used to describe collectively the variety and variability of nature. It is generally understood to encompass three basic levels of organization in living systems: the genetic, species and ecosystem levels.[1] Biodiversity can be measured at each of these levels, but because plant and animal species are the most commonly recognized and most thoroughly measured units of biological diversity, public concern has until recently been focused almost exclusively on conserving species diversity.

While the scientific community has long recognized the value of biological diversity, concern over loss of biological diversity has become significant only in the recent past. Likewise, public policy debate is now growing regarding appropriate responses. In short, this debate centers on augmenting previous efforts, such as those in the United States to conserve endangered species and to establish specifically protected areas, as well as addressing broader biodiversity concerns.

During the past 20 years, evidence has grown within the United States and worldwide that the diversity of life at all levels is being eroded, and further, that this erosion has serious implications for natural systems upon which humans rely. It is becoming clear that sustainable human economic activity is dependent upon understanding, protecting and maintaining the world's many interactive, diverse ecosystems with their complex networks of species and their vast storehouses of genetic information.[2]

Plants, animals, other life forms, and the habitats they occupy provide and renew the resources that sustain life. Agricultural crops provide food for people and livestock, and fiber for cloth. Forests provide lumber, paper and fuel, protect soils and aquifers, and absorb greenhouse gases. Plants provide food, cosmetics and drugs. Animals provide meat, dairy products, leather and wool. Insects, worms and microorganisms process wastes, renew the soil, cleanse the air, fix nitrogen and provide nutrients for plants. Wetlands reduce flooding, filter surface waters, and provide food and habitat for an enormous array of fish and wildlife.

These benefits are provided by millions of species (most as yet undescribed and uncounted), each adapted to a specific ecological niche and often to a specific spot on the Earth.[3] Individuals within each of these species differ from one another in genetic makeup, resulting in further variation within species as individuals and populations interact with each other and their surrounding habitat—their geographic and biologic "neighborhood." These communities of species interacting with their physical surroundings constitute large functional units of biological life called ecosystems.

For most of the past 20 years, public concern in the United States has focused on preventing losses of individual species, resulting in such federal legislation as the Endangered Species Act, the Migratory Bird Treaty Act, the Bald Eagle Protection Act, the Marine Mammal Protection Act and the Salmon and Steelhead Conservation and Enhancement Act. Protection of individual species is crucial to the maintenance of biodiversity. But to be effective, such protection must encompass the ecosystems that support a species as well as the genetic diversity within that species. Genetic diversity enables a species to respond to changing conditions; the complexities of natural ecosystems in turn help to maintain biodiversity at both the species and genetic levels. Because human activities affect biodiversity at all levels, biodiversity conservation efforts must consider and incorporate the effects of human activity.

The rationale for conserving biodiversity has expanded over the last 20 years. In the early 1970s, public interest and support within the United States focused on preservation of endangered species—especially large, aesthetically pleasing animal species such as whales, eagles, wolves, whooping cranes and other organisms sometimes referred to as "charismatic megafauna." More recently, the public has become increasingly aware of the values of whole natural systems, terrestrial and aquatic, in addition to those of individual wild animals and plants. These systems with their component species retain water, soil and nutrients, filter pollutants and pathogens, provide agricultural and medicinal resources, support economic, educational and recreational activities, and frequently serve as indicators of the presence of environmental contaminants or other risks to human health and welfare.

Increased public awareness of the need to protect diverse natural communities and ecosystems has encouraged efforts by federal and state agencies to address the issue. A recent report by the Science Advisory Board of the U.S. Environmental Protection Agency concluded that loss of biological diversity and associated losses of habitat are among the most important ecological threats facing the United States today.[4] And a number of federal agencies participated with private sector and conservation groups in developing consensus recommendations on conserving biodiversity on federal lands. Public concern has also led to the creation or expansion of many private organizations devoted to identifying and protecting areas of natural diversity; their methods include outright purchases and donations, as well as the negotiation of easements or other long-term protective management agreements with private landowners to preserve biodiversity in designated reserves or sanctuaries.

While popular concern over biodiversity focuses on losses to and protection of "natural" ecosystems, scientific concerns are also growing over loss of biodiversity within agriculture. The techniques that produce genetically uniform strains of corn, wheat, bananas, tomatoes, chickens and cattle—those used on the majority of crops and livestock grown today—offer the benefits of controlled productivity but also the risks of uniform susceptibility to disease and environmental stress. Greater reliance upon fewer strains, breeds and races reduces the availability of genetic variants for production of new stock. At the same time, the variety of produce available for human consumption is reduced. In some cases, such as commercially grown apples, the broad assortment of regional varieties known a generation ago has been replaced, nearly universally, with a few varieties such as Macintosh, Red Delicious and Granny Smith.

The remainder of this section will review the available information on status and trends in biological diversity, current government and private efforts to protect this resource and issues to be addressed as these efforts evolve.

Assessing the Status of Biodiversity

An accurate assessment of the status of biological diversity would require detailed analyses of status and trends for species, communities, and ecosystems, and the genetic variations within and among populations, as well as an in-depth understanding of the ecological relationships and processes which link organisms to their habitats to form communities and ecosystems.

There are enormous gaps in current knowledge for most of these elements; to begin with, it is difficult to measure biodiversity with consistency and precision at any of the three primary levels. However, existing information indicates that there is cause for concern. In the majority

THE ENVIRONMENTAL MONITORING AND ASSESSMENT PROGRAM: EMAP

EMAP is a national monitoring and research program to determine the status and trends in the condition of critical ecological resources. Principal elements of EMAP include:

- Research to develop indicators of ecological condition;
- Field Monitoring using a statistically based survey design;
- Integration and Assessment to diagnose environmental problems; and
- Reporting to distribute data and information to resource managers and decision-makers.

EMAP uses seven resource categories for its fundamental research and monitoring units: forests, arid ecosystems, agroecosystems, estuaries, the Great Lakes, inland surface waters and wetlands. Data generated by EMAP will complement, supplement and integrate data gathered by other monitoring and research efforts. Implementation has been progressing steadily. A demonstration project has been completed in estuaries in the Mid-Atlantic region and on the Gulf coast of the United States. Pilot projects for indicators in forest ecosystems have been completed in both the Northeast and the Southeast United States. A regional demonstration project is being planned in the Northeast, along with a pilot study on coastal wetlands along the coast of Louisiana.

The 1991 Demonstration Project: In 1990, EMAP initiated a demonstration project in the Mid-Atlantic region of the United States—from Cape Cod southward to the mouth of the Chesapeake Bay—to evaluate the utility of regional-scale monitoring data for assessing the ecological condition of the nation's estuaries. Because monitoring every aspect of estuarine condition is prohibitively costly, EMAP monitored selected indicators: the kinds and abundance of fish; the incidence of fish gross pathology; the kinds and abundance of organisms living in the sediments (where pollutants concentrate); measures of water quality such as the concentration of dissolved oxygen in the water; concentrations of contaminants in sediments; and the toxicity of sediments to sensitive organisms.

A qualitative description of the appearance of each estuary was also made. Additionally, information is being gathered on environmental stresses, which will be used to evaluate associations between human activity and estuarine condition. This information includes estimates of point and non-point source pollutant loadings, land-use data, climate, and changes in population density and distribution. The measurements taken will be examined in a variety of ways to document the current status of Mid-Atlantic estuaries with respect to suitability for human use and health of biological communities. Measurements in subsequent years will help to document whether these attributes are getting better or worse and, if they are changing, at what rates. Information from over 200 sampling sites is presently being analyzed.

International Applications. Internationally, U.S. scientists are working with universities and governments around the world to apply relevant mapping and remote sensing techniques, to support indicator development and to adapt the EMAP sampling design to other nations. EMAP staff are also working with the United Nations Environment Program to disseminate EMAP technology, and to help catalogue and integrate existing monitoring activities on a global scale. Projects the United States has provided assistance for include:

- Using the EMAP design to determine the spatial decline of Brazil's rainforests;
- Characterizing Australia's arid lands using EMAP's landscape characterization methodology; and
- Conducting comparative studies with EMAP's soil indicators in the heavily affected forests of Czechoslovakia.

EMAP scientists have also consulted with Canada, Finland, France, Nepal, New Zealand, Romania and the former Soviet Union on appropriate methodologies for assessing ecosystem status and trends.

of cases where information on species and ecosystems in the United States is available, declines or other disturbing trends are observable. While information on current status is available for a number of species and systems, good trend information, especially over the 20-year timeframe of this report—is usually lacking. The available statistics reflect the level of effort expended in gathering them for a few species, rather than accurately describing trends for biodiversity in general.

Since the value of integral ecosystems is not widely recognized, and since most studies of biodiversity have focused on species-level measurements, it is not surprising that most available status and trend data are for individual species or for a few ecosystem types and species. Some information is available on the status of certain general ecosystem types, largely because these systems are of special concern due to prior losses or damage (wetlands, estuaries), because they are the subject of commercial interests (forests, prairies), or because they have significant recreational value (marshes supporting ducks and geese).

Of the U.S. plant and animal species listed as threatened or endangered in 1990, fully 40 percent are plants. Slightly more than 10 percent are mammals, with approximately equal proportions (about 14 percent) of birds, fishes and invertebrates, and a lesser percentage (7.3 percent) of reptiles and amphibians combined. (See Exhibit 6f.1.)

Information on genetic diversity and its implications for conservation biology is especially lacking, as is information on ecological processes—the ways in which plants, animals and their habitats interact to form ecosystems, and the manner in which these systems provide human populations with many free, life-sustaining services. Although the following section concentrates exclusively on biological diversity in relatively unmanaged systems, diversity within agricultural systems is a related subject of growing national interest.[5]

THREATENED AND ENDANGERED SPECIES IN THE UNITED STATES

	Endangered	Threatened	Total	Percent with Recovery Plans
Mammals	53	8	61	47%
Birds	74	11	85	81%
Herptiles (reptiles, amphibians)	22	22	44	70%
Fishes	54	33	87	51%
Invertebrates (Snails, clams crustaceans, insects, arachnids)	62	19	81	65%
Plants	180	60	240	50%
Total	**445**	**153**	**598**	**NA**

Note: Includes separate listings for species with separately listed populations.
Source: Department of the Interior, U.S. Fish and Wildlife Service, *Endangered Species Technical Bulletin* vol. 15, no. 11 (December 1990): p. 16.

Exhibit 6f.1

Status and Trends: Ecosystems

There is growing scientific and public interest in learning more about the extent to which communities and ecosystems are undergoing conversion or otherwise being exposed to damaging stress. No unified federal system exists for defining and describing ecosystems, or for monitoring, identifying or protecting those in distress. In addition, there are few long-term efforts to gather comparable data on specific regions or ecosystem types. From what is known, a number of factors indicate cause for concern.

- *Hawaii, California, Texas and Florida:* These states are among the nation's most biologically diverse, and they are all experiencing declines in natural communities. In Texas, nearly one-third of the plant and animal communities recently inventoried are considered to be at risk, as are over one-fifth of such communities in California and nearly half in Florida. In Hawaii, over half of all natural communities are at risk, primarily as a result of extensive clearing of the natural landscape, which contains a great number of endemic species (species found only in the Hawaiian islands) and the introduction of alien species that are displacing native ones.[6]

- *Old-Growth Forests and Tall-Grass Prairies:* Two diverse and resilient communities that once defined much of the U.S. landscape, survive now primarily in small, isolated fragments.

- *Florida Everglades:* The ecological stability of some specific major systems, such as the Florida Everglades, is in jeopardy. The Everglades ecosystem, which includes a national park and other protected natural areas, suffers from massive diversions and manipulations of the quantity and quality of surface water inflows that are vital to the maintenance of this system.

- *Wetlands:* Since the 1700s, the lower 48 U.S. states have lost more than half the original area of their wetlands to conversion and construction; seven states have lost more than 80 percent of their original wetlands. In the period from the mid-1950s to the mid-1970s, wetlands in the conterminous United States were lost at the rate of approximately 180,000 hectares per year. That rate has declined between the mid-1970s and mid-1980s to approximately 116,000 hectares per year.[7] Approximately one-third of the nation's endangered species are dependent on wetland habitat for at least part of their life cycle. (See also Chapter 6 on freshwater and wetlands).

- *Estuaries:* Polluted runoff from rural and urban sources is degrading vital U.S. estuaries such as the Chesapeake Bay, where populations of striped bass and American shad have been severely reduced and submerged aquatic vegetation is restricted to a fraction of its original range.

- *Coastal Habitats:* Other rich coastal habitats harboring significant diversity, including mangroves, coral reefs, rocky intertidal areas and kelp forests, are under stress.

Status and Trends: Plant and Animal Species

One of the key biodiversity protection programs in the United States is that authorized by the Endangered Species Act. The Act provides protection to species formally designated ("listed") as either threatened or endangered, with the latter designation connoting greater threat and thus a higher level of protection. "Recovery plans" are developed, as resources permit, for listed

species. These plans describe the steps required to ensure recovery of the species, but are not enforceable; recovery plans have been approved for 61 percent of the listed species and are being developed for another 22 percent. The number of species in the United States listed as threatened or endangered under the federal Endangered Species Act has grown from 49 in 1970 to 598 in 1990.[8] Some of this increase is clearly a result of the level of effort devoted to the task—few species are removed from the list, and more are added each year. In addition, some 3,700 "candidate" species await consideration under the act. Exhibits 6f.1 and 6f.2 provide additional data on the numbers and status of listed species. Additional information on specific species is included below.

Other overall estimates of biodiversity loss include those developed by state natural resource inventory programs. These programs, usually entitled "Natural Heritage Programs," are an outgrowth of the work of The Nature Conservancy (TNC), a national, non-governmental citizen's membership organization involved in conservation activities.[9] These programs, in aggregate, have determined that nearly 9,000 domestic plant and animal species are at risk, including approximately 3,000 plants and 350 vertebrates that have become limited to 20 or fewer populations in the United States.

Birds. Data on the nation's bird life are more complete than for other wildlife groups. Of the more than 9,000 bird species in the world, between 12 to 15 percent occur in the United States.

A recent government study of 237 species of birds in the United States found that 28 of those species had unstable or declining populations. About two-thirds of the unstable or declining species were associated with wetlands. Information from large-scale voluntary survey efforts by the National Audubon Society have identified a widespread decline in woodland songbirds, particularly long-distance migrants wintering in the neotropics. Loss of nesting and winter habitat and continuing pesticide contamination appear to be major causes of these declining bird populations.

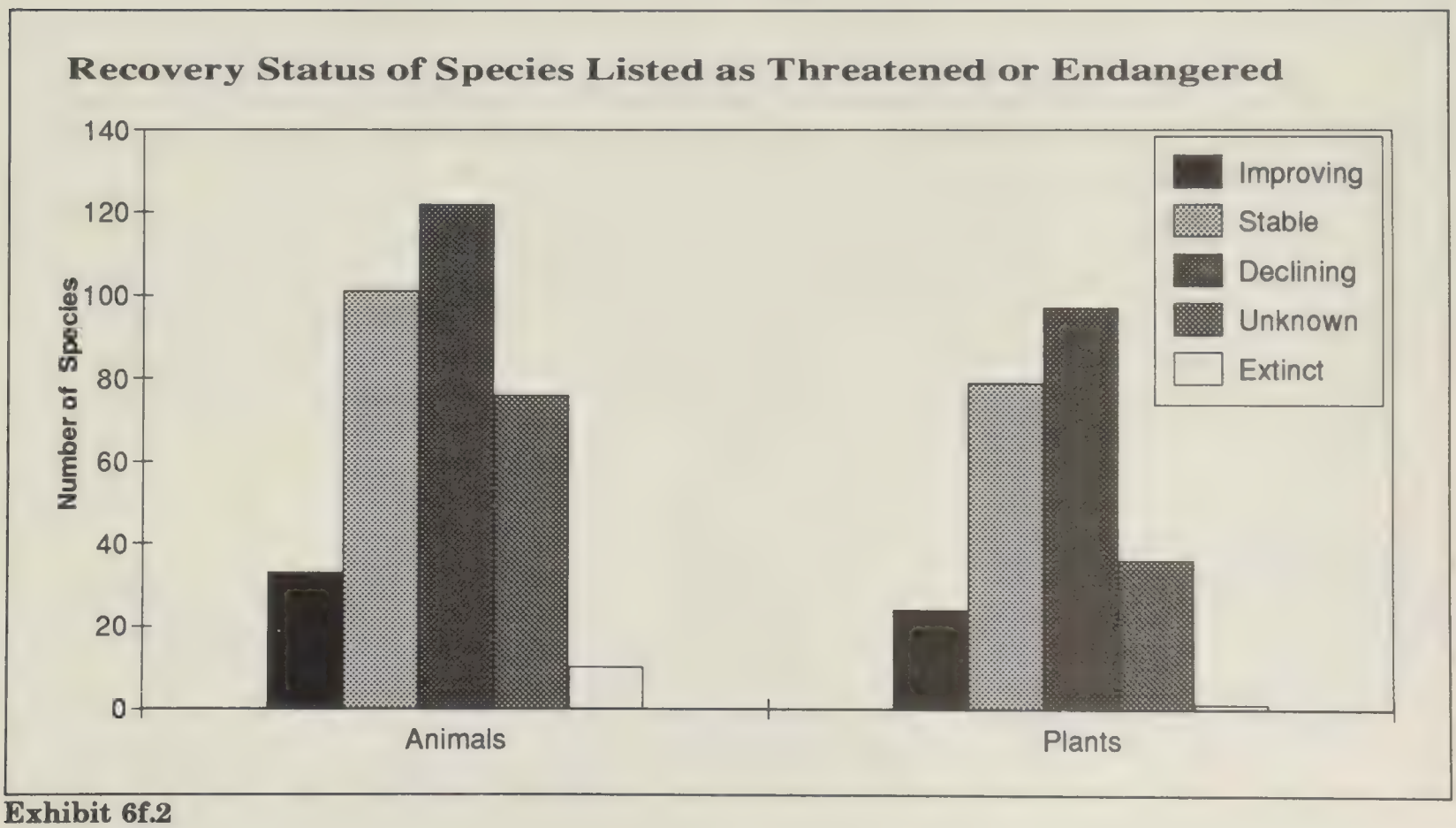


Exhibit 6f.2

Other trend data for birds indicate the following:

- Populations of many raptor species are below historical levels, although the overall status of most species is good. Nevertheless, concern exists for certain species within certain regions: Gray Hawk—Southwest, Snail Kite—Southeast, Ferruginous Hawk—West.

- The 16 species of egrets and herons occurring in the United States have rebounded dramatically since the turn of the century, when hunting them for their feathers was outlawed. Although by the 1970s most species had expanded to their former range limits, total numbers are still probably much lower than in historic times. Wetland losses are among the reasons these species have not reached their former numbers.

- Notable declines in duck populations have occurred during the past 20 years. Since 1970, breeding populations for 10 major duck species have declined by more than 30 percent. These declines are attributed to loss of wetlands, coupled with several severe summer droughts in the mid-continent. Many goose populations, in contrast, are relatively healthy since their breeding grounds are located north of current areas of human disturbance.

Reptiles and Amphibians. The United States has approximately 530 species of herpetofauna (amphibians and reptiles), with the majority (330) found in the eastern half of the country. The greatest commonly recognized threat to amphibians is habitat loss from draining, acidification and pollution of wetlands. U.S. populations of frogs and other amphibians are experiencing an unexplained decline that is also occurring in many parts of the world.

Fishes. More than 350 species and subspecies of fishes—approximately one-third of those found in the United States—are estimated to need protection because of their rarity, although only 87 have been formally listed as threatened or endangered.[10] Over the last 100 years, extinctions have occurred in the highest numbers in the Great Lakes and the Great Basin. Although over-harvesting has contributed to perhaps 15 percent of the losses, habitat alterations and the introduction of non-native sport fishes have been much more significant.

Alien or exotic fishes (those not native to U.S. waters), and introduced fishes (native to the United States, but outside of their original range) represent a special threat. More than 120 exotic species have been collected in U.S. waters. Of these, 46 have established reproducing populations, 11 since 1980. Many of these species represent serious threats to the native fish species, either because they compete for food or habitat or because they are predators on native fish species.

Protection of Biodiversity in the United States

A sizable body of state and federal legislation has been enacted during the past 20 years to provide for the improvement of plants, fish and wildlife, habitats and ecosystems. Many of these programs address important aspects of biodiversity (e.g., wetlands, forest management, endangered species), yet none contains an explicit, comprehensive mandate for biodiversity protection. As suggested above, there is increasing concern that, as a whole, these programs are not preventing erosion of the nation's biological diversity.

Federal Legislation and Programs

A host of federal laws address issues related to, but not explicitly directed towards, biodiversity protection. (See Exhibit 6f.3). Other laws, primarily those aimed at pollution control, may be used to some degree to protect biodiversity in addition to their primary objectives of protecting human health and the environment. These and other laws constitute a framework for the protection of living resources and their habitats.

Through the laws and federal programs, the government addresses issues directly or indirectly related to the conservation of biodiversity. Direct activities include managing protected areas, surveying and monitoring, managing species and ecosystems, designating research areas, maintaining germplasm banks, and conducting biodiversity research. Many other activities, including the Clean Water Act wetlands regulation program and multiple-use management of federal lands, assist indirectly in conserving natural biodiversity, as do programs of museums and botanical and zoological gardens, and public education activities.

Federal agencies have begun to undertake activities explicitly directed at the preservation of biodiversity. For example:

- Research on ways to measure, monitor, protect and enhance biodiversity;
- Training to make natural resource managers more familiar with the concept and with ways to integrate biodiversity into land management and planning;
- Inclusion of biodiversity in agency land management standards and guidelines;
- Development of shared inventory and databases with private organizations such as The Nature Conservancy;
- Designation of special areas to promote ecosystem protection, conservation and research (wilderness areas, biosphere reserves and research natural areas);
- Incorporation of biodiversity into a multi-agency strategic planning process. This is being done for such areas as the greater Yellowstone ecosystem where adjacent lands and resources are managed by more than one agency.

As is noted in the section of this chapter on land and mineral resources, federally managed lands constitute nearly one-third of the United States, and are managed under numerous laws for a variety of purposes. There are several categories of lands being managed primarily for preservation of the existing natural communities. These include national parks, national wilderness areas, national wildlife refuges, national wild and scenic rivers, national marine sanctuaries and national estuarine research reserves. As is shown in the box, the amount of land in each of these categories has increased dramatically over the past 20 years, despite relatively small increases in the overall size of federal land holdings. This is due in part to transfers of land under the Alaska National Interest Lands Act (ANILCA) from multiple-use, public domain status administered by the Bureau of Land Management to national park or national wildlife refuge status while the lands remained in federal ownership.

FEDERAL LAWS RELATING TO BIOLOGICAL DIVERSITY MAINTENANCE

COMMON NAME

Lacey Act of 1900 (wild animals)

Migratory Bird Treaty Act of 1918

Migratory Bird Conservation Act of 1929

Wildlife Restoration Act of 1937
(Pittman-Robertson Act)

Bald Eagle Protection Act of 1940

Whaling Convention Act of 1949

Fish Restoration and Management Act of 1950
(Dingell-Johnson Act)

Anadromous Fish Conservation Act of 1965
(Public Law 89-304)

Fur Seal Act of 1966
(Public Law 89-702)

Marine Mammal Protection Act of 1972

Endangered Species Act of 1973
(Public Law 93-205)

Magnuson Fishery Conservation and
Management Act of 1977
(Public Law 94-532)

Whale Conservation and Protection Study Act
of 1976
(Public Law 95-561)

Fish and Wildlife Conservation Act of 1980
(Public Law 96-366)

Salmon and Steelhead Conservation and
Enhancement Act of 1980
(Public Law 96-561)

Fish and Wildlife Coordination Act of 1934

Fish and Game Sanctuary Act of 1934

Historic Sites, Buildings and Antiquities Act
of 1935

Fish and Wildlife Act of 1956

Wilderness Act of 1964
(Public Law 88-577)

National Wildlife Refuge System Administration
Act of 1966
(Public Law 91-532)

Wild and Scenic Rivers Act of 1968
(Public Law 90-542)

Marine Protection, Research and Sanctuaries
Act of 1972
(Public Law 92-532)

Federal Land Policy and Management Act
of 1976
(Public Law 94-579)

National Forest Management Act of 1976

Public Rangelands Improvement Act of 1978
(Public Law 95-514)

North American Wetlands Conservation Act

Federal Insecticide, Fungicide and
Rodenticide Act

Comprehensive Environmental Response,
Compensation and Liability Act
(and amendments)

Clean Air Act

Clean Water Act

Toxic Substances Control Act

Oil Pollution Act of 1990

Agricultural Marketing Act of 1978
(Public Law 95-514)

Endangered Species Act of 1973
(Public Law 93-205)

Forest and Rangeland Renewable Resources
Research Act of 1978
(Public Law 95-307)

Source: Office of Technology Assessment, 1987 and Fischman, 1991.

Exhibit 6f.3

SPECIALLY PROTECTED AREAS

Areas that are specially protected in the United States range from terrestrial to coastal and open ocean sites. These areas have been designated by federal law to protect their unique characteristics and diversity of life.* Some of these specially protected areas have been designated and managed, with federal approval, by local and state governments and non-government organizations. These areas are enjoyed by millions of Americans annually.

National Park System

	Number of units	Area (million hectares)
1970	282	11.8
1990	358	32.0

National Wildlife Refuges

	Number of units	Area (million hectares)
1970	332	11.6
1990	477	35.6

National Wilderness Preservation System

	Area (million hectares)
1970	4.2
1990	38.0

National Wild and Scenic River System

	River kilometers
1970	1,389
1990	14,909

National Marine Sanctuaries

	Number	Area (hectares)
1975	2	25,856
1990	9	1,335,040

National Estuarine Research Reserves

	Number	Area (hectares)
1975	1	1,880
1990	18	103,978

* The numbers given in this table are not strictly additive, because some of the wilderness areas, and some of the wild and scenic river corridors, are located within national parks and national wildlife refuges.

Exhibit 6f.4

State Activities

States have also supported programs and activities that contribute to the protection of biodiversity. All 50 states have endangered species acts, state forest and park systems, and natural heritage programs. Approximately 40 states have established resource management systems whose explicit purpose is protection of "natural areas" or similarly designated areas.[11] Many of the properties in these systems are selected on the basis of statewide inventories of natural communities, with the goal of preserving representative examples of all, with special attention to protection of rare or threatened communities.

Most state governments now have non-game wildlife programs that include both habitat protection and public education activities directed at retarding losses of non-game species and their habitats. Finally, some states are experimenting with organizing their natural resource management efforts on the basis of ecosystems or other large landscape units.

CASE STUDY

NATURE PRESERVES AND BIODIVERSITY

The State of Illinois

Located in the upper midwestern region of the United States, the state of Illinois contains many ecological regions, from the shores of Lake Michigan, one of the Great Lakes, and remnants of once-extensive tall-grass prairie, to dense forests and productive farmlands. The state has also experienced substantial alteration of its original landscape, mostly through conversion to agriculture. There has also been extensive urbanization in the northeastern portions of the state, particularly around Chicago, an urban metropolitan region that is home to 7.2 million people. Recognizing the potential loss of significant and unique aspects of its biological heritage, the state established a Natural Areas Program to ensure the existence of representative examples of its natural systems and to protect species already endangered. Although the state purchases and maintains lands for a variety of other reasons, including game management and recreation, the Nature Preserve Program has an explicit mandate to maintain biological diversity, by identifying and preserving many of the rarer and more threatened systems and species.

The program has three major elements: inventory, protection and care. The basis for action under the program is the Natural Heritage Program, a state-managed inventory of natural systems and species. The Nature Preserve Program was established by The Nature Conservancy (TNC), a national conservation organization, and subsequently placed under state control. This inventory lists occurrences of natural systems and species, and ranks them according to their level of rarity, providing an objective means of setting state-investment priorities for acquisition.

Funded by a dedicated revenue source, the program has protected approximately 36,000 hectares, with approximately 12,000 hectares in the category receiving ''nature preserve'' designation, the highest category of protection. Approximately $4 million per year is provided to the program from the proceeds of a tax on the transfer of real estate sold within the state. The proceeds from this tax are dedicated exclusively to the natural areas and endangered species protection efforts. Purchase efforts have focused initially upon endangered species habitat, wetlands and tall-grass prairie.

These focused efforts to protect specific natural systems and endangered species are complemented by state-land purchase programs with broader goals, such as game management and recreation, and by local efforts. For example, four counties in the area surrounding heavily urbanized Chicago have authorized the issuance of $285 million in bonds for the purchase and protection of open space. Stewardship of specific natural areas is provided by a combination of trained resource management professionals and dedicated volunteers. In many areas, long-term care of the properties will involve active management, including efforts to control exotic species such as purple loosestrife and garlic mustard (which out-compete many indigenous plants and thus threaten to erode the region's diversity), and prescribed burning to maintain prairie conditions.

CASE STUDY

INTEGRATED RESOURCE MANAGEMENT INITIATIVE

The State of Minnesota

Faced with increasing and often conflicting demands on its natural resources, the state of Minnesota has begun to implement an ecosystem-based response. This reorientation is based upon moving toward an integrated approach, focusing on maintaining the health and productivity of whole ecological systems to meet expanding public needs.

A first step in the process—for which the goal is to sustain entire ecological systems—has been to identify high-priority landscape areas. Several such efforts, intended to lead to the development of government/private sector coalitions to ensure proper management, are underway.

The overall approach is to identify major landscape areas, such as large watersheds, forest areas and prairie/farmland landscapes. These areas are then the focus of integrated management efforts involving state and federal agencies, local governments and the private sector. While this initiative is in its early stages, there are indications that the state's efforts to reorganize its major natural resources agency along ecosystem lines may provide an important catalyst. Several examples initiated by the state or other agencies follow:

White River Watershed Project: Initiated by the U.S. Fish and Wildlife Service in 1987, this project began with an assessment of the poor condition of the watershed, particularly sediment and other water quality problems. The second step focused on assisting farmers with development of erosion control measures, promoting retirement of marginal, highly erodible farmland and encouraging adoption of ``best management practices'' on a 104-square-kilometer target drainage area.

Cannon River Watershed Project: The Cannon River Watershed Partnership, covering a 3,800-square kilometer area, is directed by a 26-member board of citizens, plus representatives from the area's counties and its soil and water conservation district. It was incorporated in 1990. The goal of this partnership is to ``protect and improve the surface and groundwater resources and natural systems of the Cannon River Watershed...to coordinate existing local water plans and instill a sense of 'watershed pride'...and to generally provide for cooperative management of the...Watershed.'' This initiative focuses on protecting multiple-use landscapes, typically watersheds, that contain high levels of biodiversity.

(Given the success of these two initial watershed projects, the state selected eight additional watersheds for implementation of the basin-wide management prototype.)

Prairie Stewardship Partnership: The Prairie Stewardship Partnership seeks to motivate environmentally sound and sustainable economic development, while protecting the productivity and diversity of natural ecosystems in the Northern Tall-grass Prairie. This umbrella effort includes the Minnesota Department of Natural Resources, the U.S. Fish and Wildlife Service, several environmental and conservation groups, state extension services and representatives of state private-range and grassland managers. The effort focuses on priority prairie/farmland landscapes across four states and one Canadian province, including an area in Minnesota, the Glacial Lake Agassiz Beach Ridges Landscape, which contains the largest remaining tracts of northern tall-grass prairie on the continent. Maintaining the prairie's larger bird and animal species while accommodating productive uses of the landscape depends on innovative public policies and programs, including economic incentives and technical assistance to private landowners.

Private Land Protection Efforts

Many private landowners and nonprofit conservation groups invest substantial resources to conserve biodiversity on their lands. Among the larger organized programs are those of The Nature Conservancy, with over 400,000 hectares of nature reserves in 50 states, the National Audubon Society, with 60,000 hectares of wildlife sanctuaries in 19 states and the Trust for Public Lands, which cooperates with public agencies in acquiring lands for conservation purposes. Some conservation groups and states offer registry programs that recognize private habitat protection efforts and provide technical assistance to interested landowners. Collectively, the activities of the many small nonprofit groups are substantial, since these groups exist in many, if not most areas of the country, and focus on local issues which might be overlooked by national or regional efforts.

GAP ANALYSIS OF BIOLOGICAL DIVERSITY

Since July 1987, a network of public and private interests has been developing a new tool for the conservation of biological diversity. Using computers to integrate information on land use, vegetation and animal species distributions, researchers from the Idaho Cooperative Fish and Wildlife Research Unit are able to identify landscapes with high biological diversity.

Program scientists study large tracts made up of forest and rangeland, treating them as complete ecosystems rather than as independent patches of habitat. As they study each land parcel, ranging from 10 to 1,000 square kilometers in area, they consider many animal and plant species. Areas with high biological diversity that are not under protective management are called ``gaps''—hence the program's name. Currently, gap analysis projects are underway in California, Oregon, Washington, Idaho, Utah, Nevada, Arizona, Colorado, Wyoming, Montana, West Virginia, Vermont and Massachusetts, and there are plans to extend the projects to the national level.

Gap analysis depends on state-of-the-art computers using software programs called Geographic Information Systems (GIS), which assemble, store, retrieve and manipulate electronically generated maps. Each category of information, such as vegetation types, land ownership, land management areas, distribution of birds, mammals, reptiles, amphibians and butterflies, as well as ecoregions and hydrologic units, is called a ``theme.'' Together, these themes make up the gap analysis data base. Using this technology, species, communities and ecosystems can all be considered as integrated components. This perspective contrasts sharply with the traditional species-by-species approach to biological conservation.

Gap analysis makes it possible to assess how much of the nation's biodiversity is protected and to initiate management activities to upgrade that protection. It is a powerful tool for natural resource planners and managers, enabling them to focus on high-priority conservation actions. The program is used to identify lands for acquisition and establishment of preserves. Similarly, it can be used in land restoration efforts by identifying multiple-use lands that can be more efficiently managed to maintain or enhance diversity.

Over the long term, gap analysis will supply information that managers can use to maximize the number of species and natural communities that survive into the 22nd century.

Issues in Biological Diversity

Several major issues and challenges emerge as the United States attempts to address the erosion of domestic biological diversity over the coming decades. These include:

- A growing recognition that biodiversity protection must be based on ecosystem management, rather than single-species efforts. This understanding will be important in addressing biodiversity losses and in reconciling human activities with habitat protection. Recognition of the value of ecosystems is coupled with a recognition that current laws and institutions are not structured on an ecosystem basis.

- An increasing understanding that decisions made in every sector of society can contribute either to loss or to protection of biodiversity.

- An increasing demand for better information. This includes recognition of the value of basic taxonomic work, of conservation-oriented inventories (such as the Nature Conservancy/Natural Heritage effort), and of research into ecosystem function and processes.

Ecosystem Management

Ecosystem-based management takes into account the functional relationships between species and habitats by focusing on integral ecological units—ecosystems—rather than on piecemeal management of individual elements within those systems.

Ecosystem-based approaches are gaining an increased role in achieving species- and biodiversity-protection goals. Monitoring, assessing and protecting or restoring all domestic species would be a task so large as to be, for all practical purposes, impossible. Yet failure to manage the habitats on which species rely means that an increasing number of species, in particular those adapted to specific habitats, will inevitably be at risk as those habitats become damaged, isolated or fragmented.

Further, recognition of the human factor—the existence of and need for continued human alterations in the majority of ecosystems in the United States—is vital for achievement of endangered species, habitat or biodiversity goals. Simply put, while preserves and protected areas are critical for achievement of these goals, they are insufficient. Further, ecosystem management has the potential to work at a scale sufficiently large to allow human activities and impacts to be incorporated within the constraints needed to maintain vital ecological functions.

Integrated Decision-Making

Maintaining biodiversity in a country as urbanized as the United States requires the involvement of a wide range of people and interests. Individual landowners cannot be expected to resolve, singlehandedly, the nation's problems of ecosystem fragmentation and conversion. But individual public and private decisions can either ameliorate or exacerbate such problems.

At present, there are numerous laws, regulations and policies at the federal, state and local level requiring consideration of specific aspects of biological diversity—endangered species, wetlands, stream corridors, etc. However, there are few laws requiring explicit consideration of biodiversity impacts, broadly construed.[12] Yet, even in the absence of such laws or regulations, there are many opportunities for the public and private sectors to assess the effects of their decisions on biodiversity, and adjust their activities accordingly.

Private firms develop strategic business plans, government program managers engage in program planning, and land managers in both sectors prepare periodic unit management plans and implement these on a day-to-day

basis. Each of these sectors can, and in some cases do, consider the broader systems within which their actions take place. For example, communication between adjacent landowners allows them to account for and to cooperatively manage shared resources. Federal land managers and program administrators can enhance their contacts with tribal, state and local governments and with the private sector to minimize duplication of effort, and harmonize the goals and strategies of different participants.

Information Needed to Maintain Biodiversity

Maintaining biodiversity requires attention to a broad array of elements within the environment, and to the management of functional units of the natural landscape, including the distribution, abundance, and status of the types of species extant in the United States, and more importantly, of the community associations and ecosystem processes on which they depend.

There are two major issues relating to information on biological diversity. The first is the need to ensure that information gathered by scholars in government agencies, public research institutions and the private sector is available in a usable form to others. The second is the need to augment substantially the information base that exists today.

At a very basic level, there has been extensive discussion of the need to ensure access to biological and ecological information housed in museums, colleges and universities, government databases and other private organizations. In addition, the current organization of data may, in some cases, be inconsistent with ecosystem- and biodiversity-management approaches. A first step might be cataloging available information. Creating such a "database of databases" would entail identifying and linking existing information from public and private sources. This would provide access to the best information on a subject, even if that information is, as yet, uncertain and incomplete.[13]

Far more important, however, is recognition that there are important gaps in knowledge. While biological databases, and the expertise they represent, in institutions across the United States are impressive, deficits exist in understanding the ecology of even major and relatively well-known groups of organisms—let alone the many whole taxonomic categories such as insects, mites, fungi, and microorganisms, about which scientists know very little. Commonly cited categories of needed information include:

- *Species Classification.* A significant fraction of U.S. species have not yet been formally described.

- Basic Ecological Research. Insufficient information is available on the distribution, abundance and ecological relationships of U.S. species. A coordinated and generally accepted inventory and classification of ecosystems is lacking.

- *Genetic Variation.* Knowledge of genetic variation within species based on actual empirical studies is almost non-existent except for a handful of species.

- *Ecological Processes.* Knowledge of ecological processes that govern ecosystem and landscape dynamics is rudimentary.

- *Applied Research.* Ecologically based management techniques applicable to both natural and managed landscapes are needed in order to protect ecosystems and to guide commercial development.

Summary

Biodiversity is a national and international asset for both present and future generations; sustaining that asset requires greater knowledge and wiser use of our natural resources. The public and private sectors in the United States have a role in maintaining and restoring biodiversity for its intrinsic worth, for stable ecosystems, and for human health and well-being. Achieving such a national goal need not conflict with robust economic growth. In the long run, maintaining the nation's biodiversity is essential to support a healthy economy.

Endnotes:

1. For more complete discussion of the scope and elements of biological diversity, see: U.S. Congress, Office of Technology Assessment, *Technologies to Maintain Biological Diversity*, (Washington, D.C.: U.S. Government Printing Office, 1987), p.3, and J.A. McNeely, K.R. Miller, W.V. Reid, R.A. Mittermeier, and T.B. Werner, *Conserving the World's Biological Diversity*, (IUCN Publications, Gland, Switzerland, WRI Publications, Baltimore, Maryland, and World Bank Publications, Washington, D.C., 1990).
2. For further information on the material benefits of biodiversity, and on how and why biological resources are threatened, see Council on Environmental Quality, *Environmental Quality: the Eleventh Annual Report of the Council On Environmental Quality*, (Washington, D.C.: U.S. Government Printing Office, 1980) Chapter 1; E.O. Wilson, (ed.), *Biodiversity*, (Washington, D.C.: National Academy Press) and J.A. McNeely, et al., *Conserving the World's Biological Diversity*.
3.. E.O. Wilson, in *Biodiversity*, cited in note 2, reviews various estimates of the total number of species on Earth, and, based on his own work and that of other specialists, makes a "guess" that "the absolute number falls somewhere between five and 30 million."
4. U.S. Environmental Protection Agency, *Reducing risk: setting priorities and strategies for environmental protection*. SAB-EC-90-021 (Washington, D.C.: 1990).
5. See National Research Council, *Alternative Agriculture* (Washington, D.C.: National Academy Press 1989).
6. Council on Environmental Quality, *21st Annual Report on Environmental Quality* (April 1990).
7. T.E. Dahl, *Wetland Losses in the United States 1780s to 1980s*, (Washington, D.C.: U.S. Department of the Interior, Fish and Wildlife Service 1990), 21 pp.

   T.E. Dahl and C.E. Johnson, *Status and Trends of Wetlands in the Conterminous United States, 1970s to 1980s*, U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. (Pending publication, 1991).
8. In some cases, separate populations of species are both listed and counted twice. See also Department of the Interior, 1990.
9. The Nature Conservancy (TNC) established a program to collect data on the location and status of known species and ecosystems in the United States, and to rank their relative scarcity. These programs have been established in every state, and have been transferred to state government control and financing with technical oversight by TNC.
10. Jack E. Williams, et al., "Fisheries of North America, Endangered, Threatened, or of Special Concern," *Fisheries*, vol. 14(6) (1989): pp. 2-20.

11. Approximately 20 of these are established under state legislation; the remainder are less formally constituted. In addition, the terms used vary among states: natural areas, nature preserves, nature areas and science preserves are common designations.

12. The National Forest Management Act (NFMA) requires national forestland management plans to provide for diversity of plant and animal communities. The Council on Environmental Quality's National Environmental Policy Act (NEPA) regulations provide for federal agency consideration of all 'reasonably foreseeable' impacts of major federal actions.

13. Council on Environmental Quality, *21st Annual Report on Environmental Quality*, April 1991.

G
Toxic Substances

Overview

Twenty years ago, public and government interest in the environment was focused primarily on improving the nation's air and water quality. The U.S. Environmental Protection Agency (EPA) had been created in 1970, following the enactment of the Clean Air Act, and Congress was in the process of writing sweeping legislation to control water pollution that would shortly become the Clean Water Act Amendments of 1972. There were some early warnings of special problems traceable to chemicals known to be toxic to human beings or other species. Rachel Carson's prescient book, *Silent Spring*, published 10 years earlier, had warned of the unintended consequences of DDT and other pesticides that were accumulating in natural systems; a 1971 report by the Council on Environmental Quality summarized environmental and health problems associated with the proliferation of toxic chemicals, including metals such as mercury, cadmium and lead, and synthetic organic chemicals such as pesticides and polychlorinated biphenyls.[1]

In his 1971 environmental message to Congress, President Richard Nixon proposed new legislation to achieve better control of pesticides and to establish a new federal regulatory program affecting the distribution and use of other toxic substances.[2] Congress enacted major changes to strengthen the federal pesticide laws in 1972, and the proposed Toxic Substances Control Act was enacted in 1976.[3] The problems addressed by these major environmental laws, and the programs established by them to do so, are summarized below.

The United States regulates the use of pesticides through the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), the residues of pesticides on foods under the Federal Food, Drug and Cosmetic Act (FFDCA), and the use of other toxic chemicals primarily through the Toxics Substances Control Act (TSCA).[4] FIFRA and TSCA enable the U.S. government to prevent the generation and use of new chemicals which may pose unreasonable risk, to manage the use of existing chemicals whose benefits outweigh their risks and to remove from the marketplace chemicals (and products containing them) that are shown to carry unreasonable health or environmental risks.

In the last few years, these laws have been strengthened, and they are now being revitalized and supplemented. FIFRA was reauthorized in 1988 with new authorities and resources to re-register pesticides that were registered before 1984 in order to bring relevant information about them (toxicity, fate and transport, exposure, ecological effects, etc.) up to modern scientific standards. Important changes in the regulation of toxic substances came with passage of the Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986, which provided communities with unprecedented access to information on releases and transfers of toxic chemicals from manufacturing facilities. Existing authorities under TSCA are being used to stimulate more approaches to preventing pollution. Pollution prevention was articulated as a national goal in the Pollution Prevention Act of 1990.

This section discusses environmental issues related to the production of pesticides and industrial toxic chemicals, and the emerging emphasis on pollution prevention. Issues related to the effects of toxic pollutants in air and water were discussed briefly in the sections on air and atmosphere, freshwater and wetlands, and oceans and coasts; issues related to toxic waste are addressed in the section on wastes. Problems of spills and other accidental releases of hazardous chemicals are discussed in Chapter 7. Pesticides are also discussed in Chapter 4.

Pesticides

Under U.S. law, the term "pesticides" includes insecticides, herbicides, rodenticides, fungicides, nematicides and acaricides, as well as disinfectants, fumigants, wood preservatives and plant growth regulators—agents used to kill or control undesired insects, weeds, rodents, fungi, bacteria or other organisms.

Although societies have attempted to control household and agricultural pests with various substances for many centuries, synthetic organic pesticides were not widely used until after World War II, when DDT and several other pesticides became commercially available. Chemical pesticides quickly became an integral part of American agricultural production, and contributed importantly to the most economical, plentiful and safest food supply in the world. At first, consumers, farmworkers and growers largely judged these chemicals only on their cost and effectiveness in controlling the intended pests. But concerns gradually mounted about the unintended toxic effects of chemical pesticides. Pesticide residues in food, farmworker exposure to pesticides, pesticide contamination of surface and groundwater, soil contamination from pesticide residue or illegal dumping of pesticide containers, and adverse effects on birds and other wildlife all contributed to a growing public unease over the widespread use of pesticides.

These concerns have led to some beneficial results. In agriculture, new strategies have been developed to minimize the level of exposure from pesticides to growers and consumers; practices include the use of natural predators and other biological controls, pest-resistant crop varieties, special crop management practices, and a strategy called integrated pest management (IPM) that combines these and other techniques. Growers are also becoming more cognizant of pollution laws and regulations, and are implementing new pesticide application and handling practices. All of the above-listed improvements indicate progress, but more still needs to be done.

Pesticide Regulatory Programs

Federal activities to control pesticide use are mandated under FFDCA and under FIFRA, originally enacted in the 1940s, with environmental protection provisions added during the 1970s. Before a new pesticide may be marketed or used in the United States, it must be officially "registered" by the federal government. The U.S. government is responsible for ensuring that the chemical, when used according to label instructions, will not present unreasonable risks to human health or the environment. Registration decisions give consideration to economic, social, and environmental costs and benefits. Pesticide registration decisions are based primarily on an evaluation of test data that applicants are required to provide. Testing is needed to determine whether a pesticide has the potential to cause adverse effects on humans, wildlife, fish or plants. Since the testing requirements vary according to the type of pesticide and its intended use, the government can require between 40 and 250 specific tests for each pesticide.

In considering the registration of a pesticide, regulatory options include denying registration, placing limits on the amounts that may be applied or the frequency or location of application, and restricting use of the pesticide to specially trained, certified applicators. Between 10 and 15 new pesticide active ingredients are usually registered each year by the Environmental Protection Agency.

Registration of a pesticide for use on processed food or raw agricultural foods requires establishment by EPA of a "tolerance" or legally enforceable residue limit. Two federal agencies, the Food and Drug Administration (FDA) and the U.S. Department of Agriculture (USDA), monitor domestic and imported food for compliance with tolerance levels. USDA monitors meat, poultry and egg products, while FDA monitors all other foods. Currently, 35 states also monitor foods sold within their borders for pesticide residues and other contaminants.

FIFRA requires the government to reevaluate the safety of pesticides that were registered before current scientific and regulatory standards were formally established. In 1988, dissatisfied with the pace of reevaluation of older pesticides, Congress passed amendments to FIFRA requiring the EPA to accelerate the reregistration process, and to complete it by 1997; that process is now underway.

FIFRA also authorizes the cancellation or suspension of a registration when evidence indicates that the risks of a pesticide may outweigh the benefits. Over the past 20 years, the United States has banned DDT, canceled the registration of 34 other pesticides and eliminated the use of 60 toxic inert ingredients. Eliminating the use of pesticides (such as DDT, chlordane, etc.) has proven quite successful in reducing the levels of these pesticides in humans, fish and wildlife, but low-level contamination still occurs.

Other government activities related to pesticides include setting standards to protect agricultural workers, certifying and training applicators, providing information on the health effects of pesticides and on pesticide poisonings through the National Pesticide Telecommunications Network, and encouraging implementation of best management practices in the use of agricultural chemicals under state "non-point" source management programs and the Coastal Zone Act Reauthorization Amendments. Recently, the federal government has become more involved in assessing the threats posed by pesticide use to endangered species, reviewing the need for improved storage and disposal of pesticides and pesticide containers, developing a strategy to prevent further contamination of groundwater by pesticides, and setting worker-protection standards. The federal government is also setting standards for the storage and disposal of pesticides, including provisions for the design and recycling of containers.

Pesticide Use and Environmental Trends

Trends in Pesticide Use. Approximately 25,000 commercially formulated pesticide products are currently registered for marketing and use in the United States. The federal government regulates these products primarily on the basis of their pesticidal active ingredients (the components of a pesticide product that act on the pest). There are about 900 active ingredients currently in production.[5] Six hundred of these active ingredients were registered before 1984 and, therefore, are subject to the re-registration process to ensure that older chemicals meet current safety and scientific standards.

Total annual pesticide use in the United States is estimated at almost 9.5 thousand-million kilos of active ingredients. Of this amount, almost 500 million kilos are wood preservatives, disinfectants and sulfur (as a fungicide). The remaining 500 million kilos are "conventional" pesticides—herbicides, insecticides and other fungicides.[6] Use trends for these conventional pesticides is shown in Exhibit 6g.1:

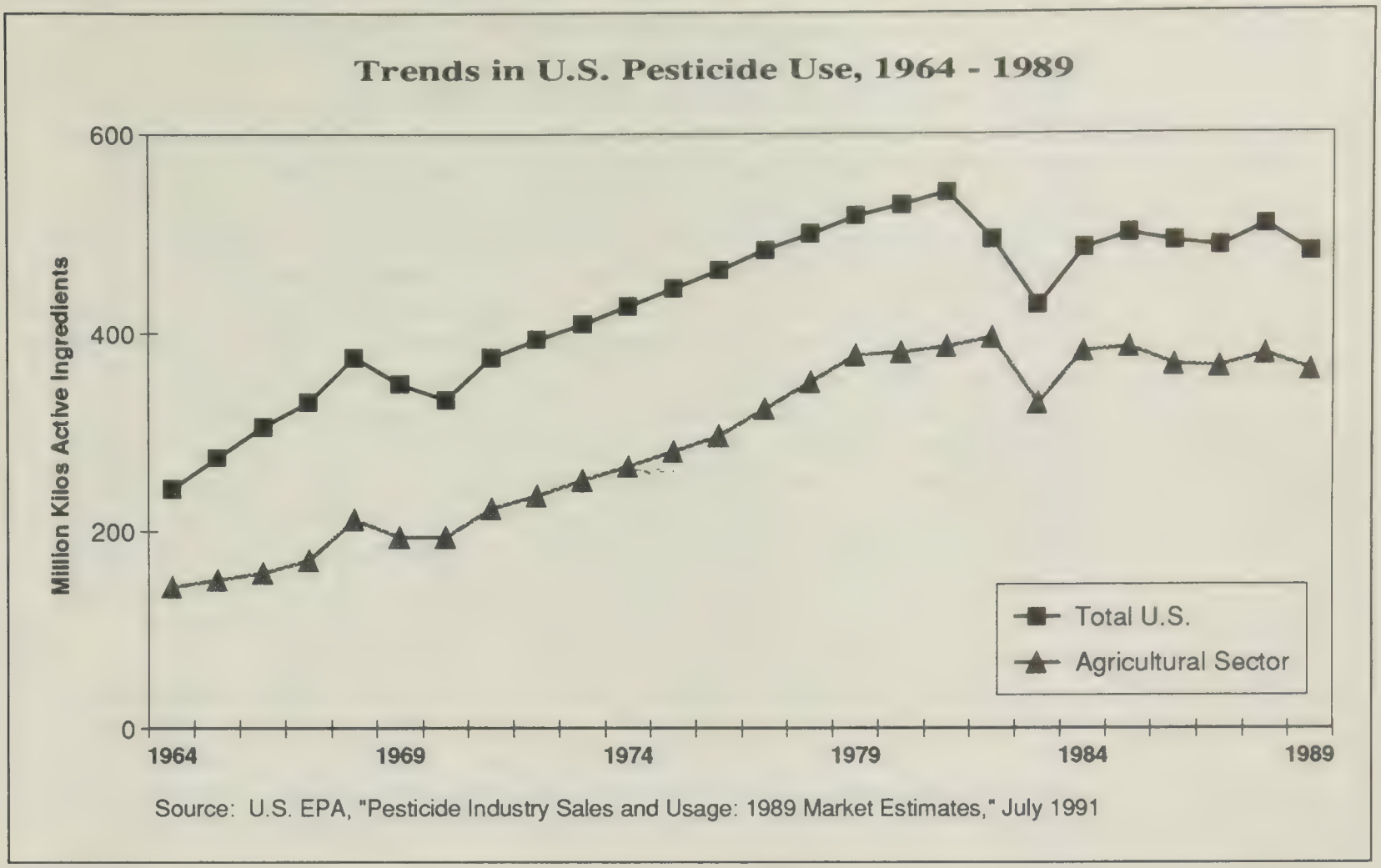


Exhibit 6g.1

After increasing steadily throughout the 1960s and 1970s, pesticide use reached an all-time high in the early 1980s; more recently total use appears to be holding steady at slightly lower levels. More efficient use of pesticides, the availability of more effective pesticides and use of alternative pest control methods all contribute to this trend.

In the conventional pesticide market, agriculture accounts for over two-thirds of pesticide user expenditures and about three-quarters of the total amount used annually; the remainder of the market consists of industry, government, and home and garden uses. Herbicides are the leading type of conventional pesticide, accounting for over 50 percent of domestic sales and of the total amount of pesticides used.

Pesticides in Surface Water. The long-term effects of pesticides on aquatic ecosystems or human health are not fully understood. Pesticides diluted in surface waters are difficult to analyze, and detection limits are highly variable among pesticides. But some broad patterns have been recognized.[7]

A combination of increasing regulatory restrictions and decreasing effectiveness of organochlorine insecticides, such as DDT, chlordane and dieldrin, has led to a dramatic decrease in their use since the mid-1960s, and an erratic decrease in their occurrence in water and sediment samples since 1975. However, because organochlorine insecticides degrade very slowly compared to some other pesticides, their residues continue to be found in sediments. Farm use of organophosphate insecticides, such as malathion, parathion and diazinon (which are short-lived and highly soluble in water) likewise declined steadily through the 1970s. No trends in their occurrence or detection are evident in inland waters or bed sediments, regionally or nationally.[8]

The United States Geological Survey (USGS) conducted a reconnaissance sampling in 1989 for 13 herbicides and metabolites (mainly triazine herbicides plus alachlor and metolachlor) in the water collected from streams in midwestern states over a one-year period. This 10-state region was selected because about 60 percent of the pesticides used in the United States are applied there; this area produces 75 percent of the nation's corn and 60 percent of its soybeans. A total of 122 hydrologic units, totalling over 512,200 square kilometers (median size 4,087 square kilometers), were sampled at three different times: before herbicide application, during the first storm runoff after application, and during the low-flow fall period. During the first two periods, detectable amounts of the triazine herbicides were found in low concentrations at 90 percent and 98 percent, respectively, of the 127 sampled sites.[9] Atrazine was most common. During the first storm runoff sampling period, amounts of atrazine exceeding the health advisory levels were detected at 56 percent of the sites. The fall sampling yielded detectable amounts of herbicides at low concentrations at 79 percent of 145 sampled sites. Based on 1990 results, the levels found for several herbicides during the late spring and summer can persist above the proposed maximum contaminant levels for several weeks to several months.[10]

The occurrence of herbicides in the early spring (before application) and fall sampling periods indicates that detectable amounts of the sampled herbicides persist below health advisory levels year-round in some locations. Since the same pesticides have been detected in groundwater, groundwater discharge may contribute to their apparent perennial presence in some streams.

Pesticides in Rainwater. Various scientific studies have reported the presence of herbicides in rainwater in recent years. This occurs because some of the herbicides applied to farm lands vaporize into the atmosphere, usually during a one- to two-month period in late spring. The airborne chemical vapors can be transported by winds to other locations where rainfall deposits them on land surfaces, lakes, streams and vegetation.

A U.S. Geological Survey study during 1990 was the first to measure the seasonal and geographic occurrence of herbicides in rainwater over a large area—23 states extending from Kansas to Virginia and to the Canadian border. The study tested for atrazine and chloro-acetanilide herbicides, such as metolachlor and alachlor, on a weekly basis at 81 sites from March to September 1990. These herbicides were used in all states; the Midwest was identified as the major, but not the only, source of these chemicals to the atmosphere.

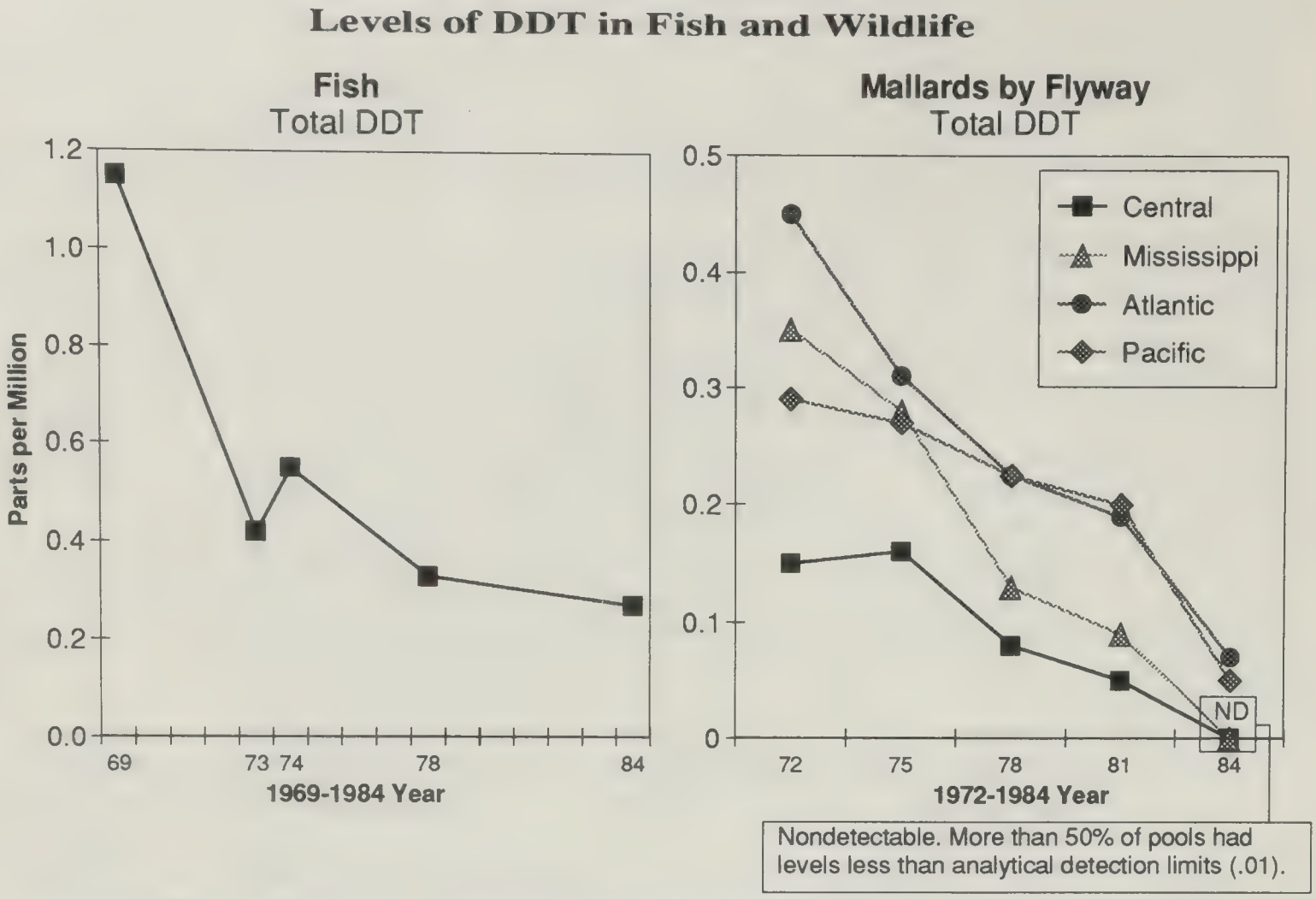
Traces of herbicides were detected in rain samples in all 23 states and at all but two sites. The predominant herbicides detected were atrazine, alachlor and metolachlor; detections were greatest following late spring applications. Concentrations in individual samples exceeded several parts per thousand-million at many sites in the Midwest, where the heaviest use occurs, but averages for the April-to-July period did not exceed one part per thousand-million (one-third of the proposed EPA drinking-water health advisory level for atrazine) at any station.

Pesticides in Groundwater. Although many pesticides break down into benign substances soon after application, some leach through the soil into groundwater, where they may present a risk to the health of those who use that water for drinking or other domestic purposes. In 1988, data collected by the Environmental Protection Agency showed that 46 pesticides had been found in groundwater in 26 states as a result of normal agricultural use.[11] In most cases, the pesticide concentrations were at very low levels; some of the substances detected, such as DDT, chlordane and EDB, are now banned or under severe use restrictions.

The recently completed National Pesticide Survey of Drinking Water Wells found that 10 percent of the nation's community drinking water wells and about four percent of rural domestic drinking water wells may have detectable residues of at least one pesticide, although the concentrations of these pesticides exceed health-based criteria in fewer than one percent of all wells. These studies indicate that pesticides in groundwater do not constitute substantial or widespread threats to public health. They do show, however, that groundwater resources are vulnerable to pesticide use. Once groundwater has become contaminated, it is often neither economically nor technically feasible to restore the resource. For these reasons, prevention of such contamination has become the primary focus of the federal government's protection efforts.

Pesticides in Fish and Wildlife. Adverse effects of pesticides on fish and wildlife, including endangered species, were first detected more than 30 years ago. America's bald eagle population, for example, was seriously threatened by the widespread use of DDT and other organochlorine pesticides until they were banned in the 1970s. The number of bald eagles in the lower 48 states has increased from as few as 400 nesting pairs in the early 1960s to over 2,660 nesting pairs in 1989. Other threatened species have also shown signs of recovery, including the California brown pelican and the peregrine falcon. The levels of DDT and other organochlorines in the tissues of fish and birds have declined significantly since the early 1970s.[12] Despite the U.S. ban on DDT, organochlorine compounds remain a concern. Some birds are exposed to these compounds when they migrate south to winter in countries where organochlorine pesticides are commonly used. (See Exhibit 6g.2.)

The circumstances surrounding the banning of DDT revealed some weaknesses in the U.S. regulatory process. DDT and other banned organochlorine pesticides were replaced by other chemicals that were much more acutely toxic to farmworkers and that also posed risks to wildlife. Focusing regulatory attention on one pesticide at a time, without considering the impacts from chemicals that would take its place, can result in use of substitutes that pose even higher risks or different kinds of risk.

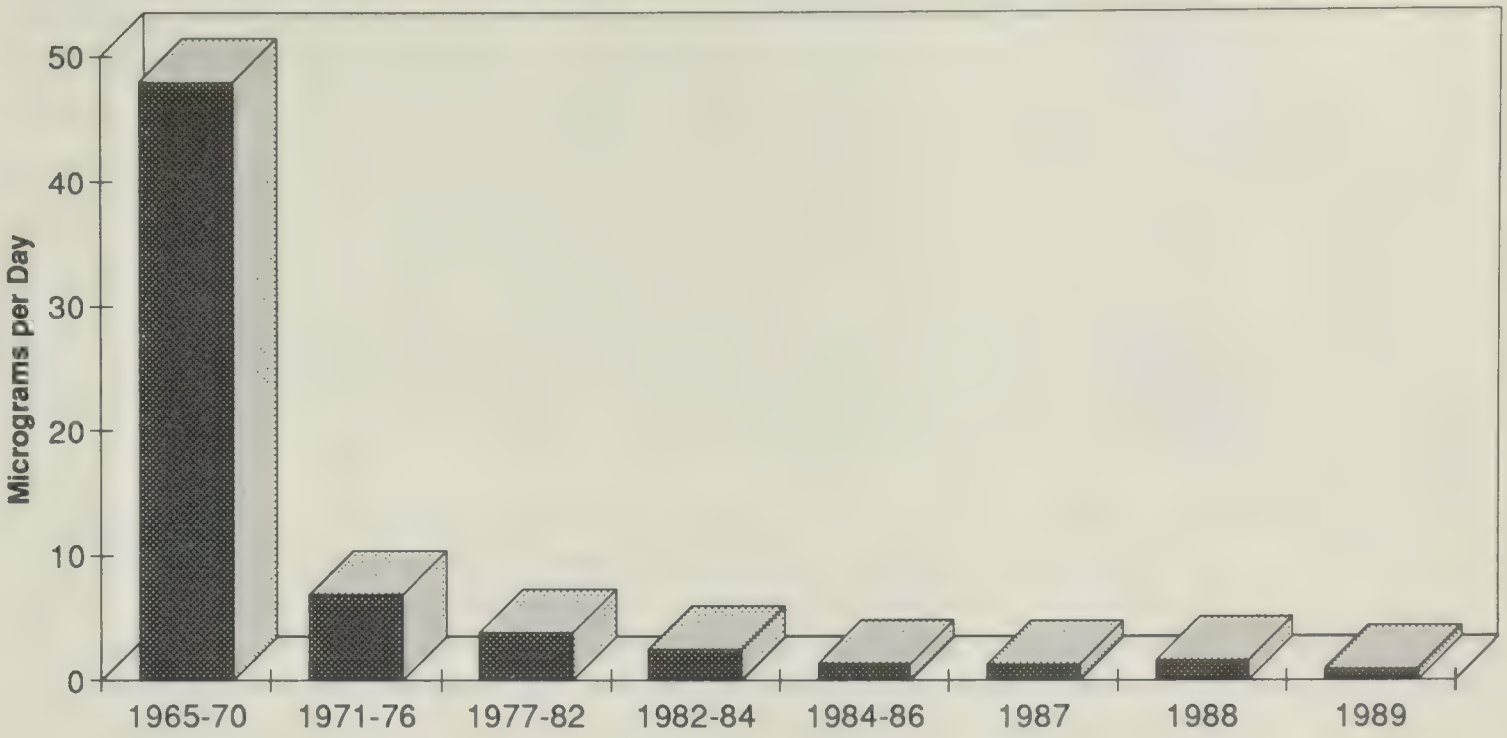


Source: U.S. Fish and Wildlife Service, National Contaminant Biomonitoring Program, unpublished data for 1984.

Exhibit 6g.2

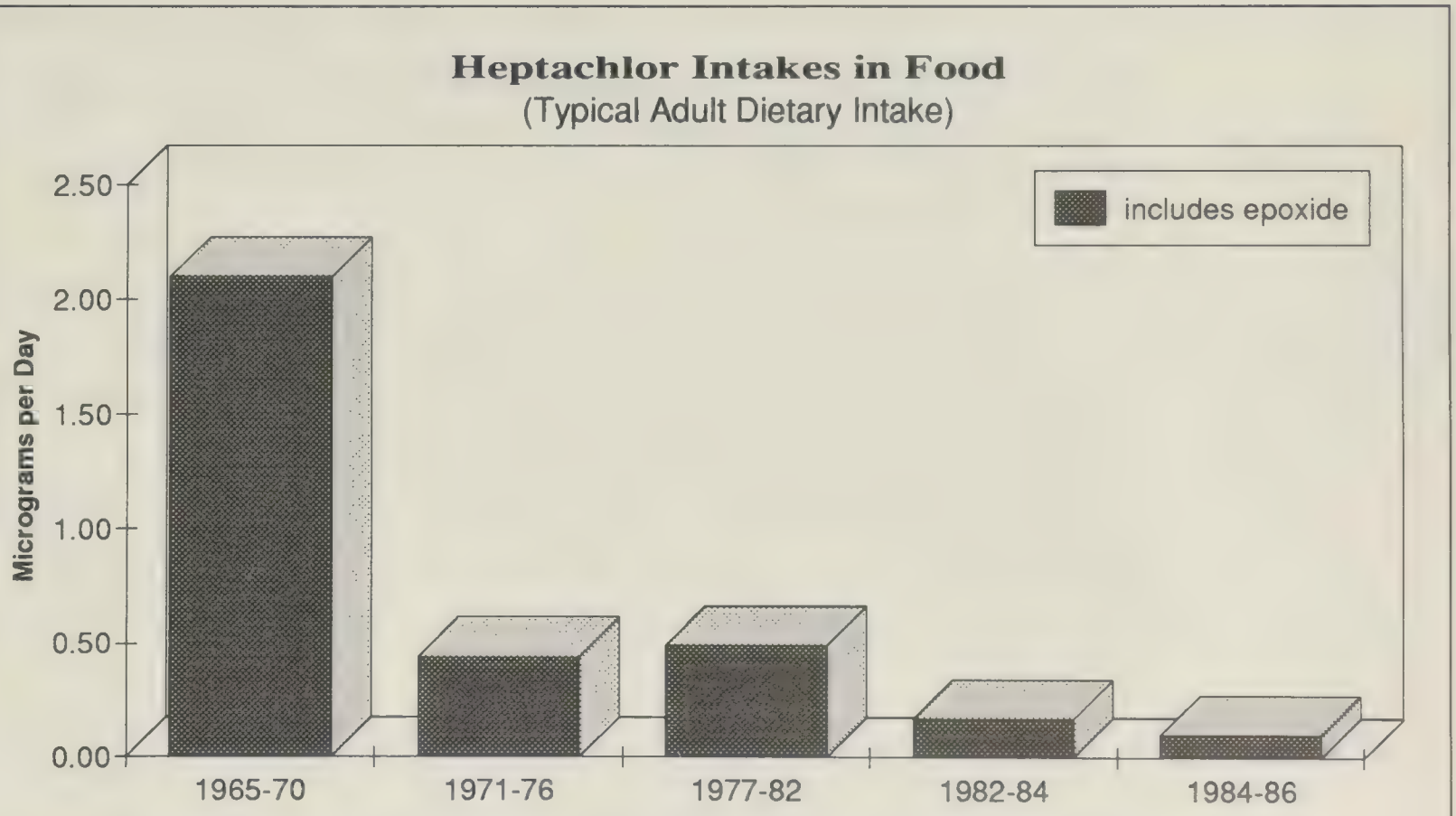
Pesticides in Food. Data from the Food and Drug Administration's Total Diet Study (also known as the Market Basket Study), which measures the U.S. consumer's daily intake of pesticide residues from foods that are bought in supermarkets and grocery stores, and prepared or cooked as they would be in a household setting, show that dietary levels of most pesticides are less than one percent of the "reference dose"—the level of daily exposure to the pesticide that is considered acceptable for humans. The Total Diet Study has demonstrated that U.S. dietary intakes of organochlorine pesticides such as DDT and heptachlor have decreased dramatically over the last decade as their uses have been discontinued. (See Exhibits 6g.3 and 6g.4.)

Imported foods receive special attention in FDA's monitoring program. Above-tolerance residues in 1987 and 1988 were found in less than one percent of the imported foods that were sampled. Even so, FDA has tightened its import policy in the last few years: if a single shipment from a given source is found to violate U.S. tolerance regulations, all shipments from the same source are subject to automatic detention.



Source: U.S. Department of Health and Human Services, Food and Drug Administration, *Total Diet Study.*

Exhibit 6g.3



Source: U.S. Department of Health and Human Services, Food and Drug Administration, *Total Diet Study.*

Exhibit 6g.4

Each year, the U.S. Department of Agriculture conducts 10,000 to 20,000 pesticide residue analyses of meat and poultry products. *Currently, fewer than one percent of these tests show illegal residues, and the violation rate has been declining steadily over the last two decades.* State regulatory agencies are also involved in monitoring the safety of the food supply; some states have their own pesticide residue regulations for food produced within state boundaries. Under no circumstances, however, can a state or local government relax federal pesticide standards.

In summary, U.S. government programs are intended to make certain that any pesticide residues contained in foods are below levels that would constitute a significant health risk. Continual regulatory review and monitoring are serving to reduce or eliminate unnecessary risks; overall risks from pesticides in the diet are decreasing, and the remaining risks should be considered in light of the substantial health benefits provided by the nation's nutritious and abundant food supply.

Pesticides in Humans. Organochlorines are man-made chemicals that are persistent (long-lasting) in the environment. They have serious ecological effects, such as eggshell damage by DDT and other organochlorines. They are toxic to humans and other animals in very low doses. Therefore, the United States has focused regulatory attention on these chemicals. Organochlorine pesticides are found in adipose (fatty) tissues of virtually everyone in the United States, but in many cases the concentrations are declining. The levels are not acutely hazardous, although many individual poisonings and pesticide-related illnesses have been treated.

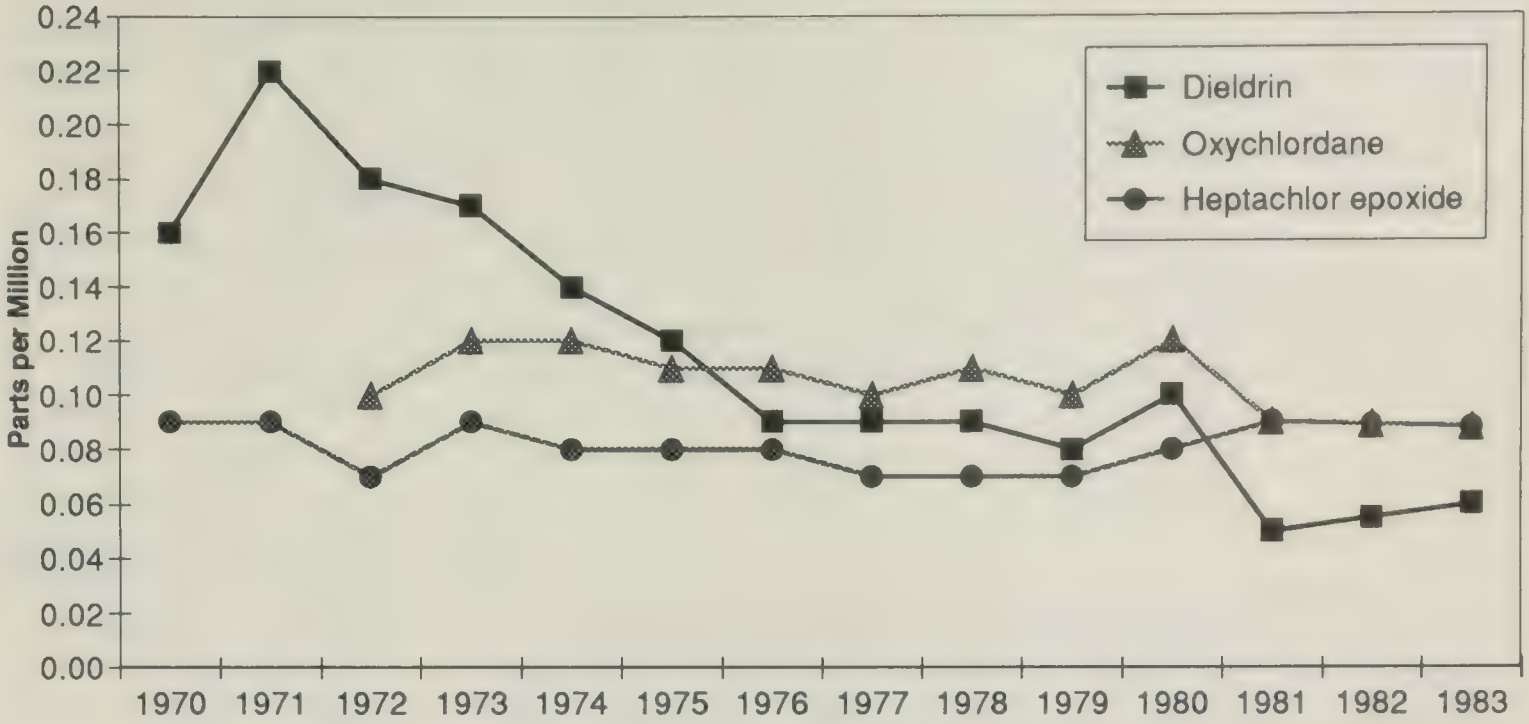
As shown in Exhibit 6g.5, between 1970 and the early 1980s (more recent data are not available), dieldrin concentrations in fatty tissues declined, whereas oxychlordane and heptachlor epoxide, representative of the pesticides chlordane and heptachlor, remained at relatively constant levels. There has been a steady reduction in the concentration of DDT in human tissue samples. (See Exhibit 6g.6.) Most uses of DDT were banned in 1972, but the occurrence of this persistent compound in human adipose tissue is still widespread throughout the nation.

Issues in Pesticide Regulation

Safer Alternatives and Pollution Prevention. Over the last five to six years there has been increasing interest in alternative farming practices that depend more on on-farm techniques to control pests and satisfy nutrient requirements. These alternative practices are known by different names—such as biological, integrated, regenerative and sustainable agriculture. Sustainable agriculture, which has emerged as the most common name, uses pesticides and inorganic fertilizers, but not as the only tools. It includes more thorough incorporation of natural processes such as nutrient cycling, nitrogen fixation and knowledge of pest-predator relationships into the agricultural production process. Sustainable farming practices vary from farm to farm but commonly include:

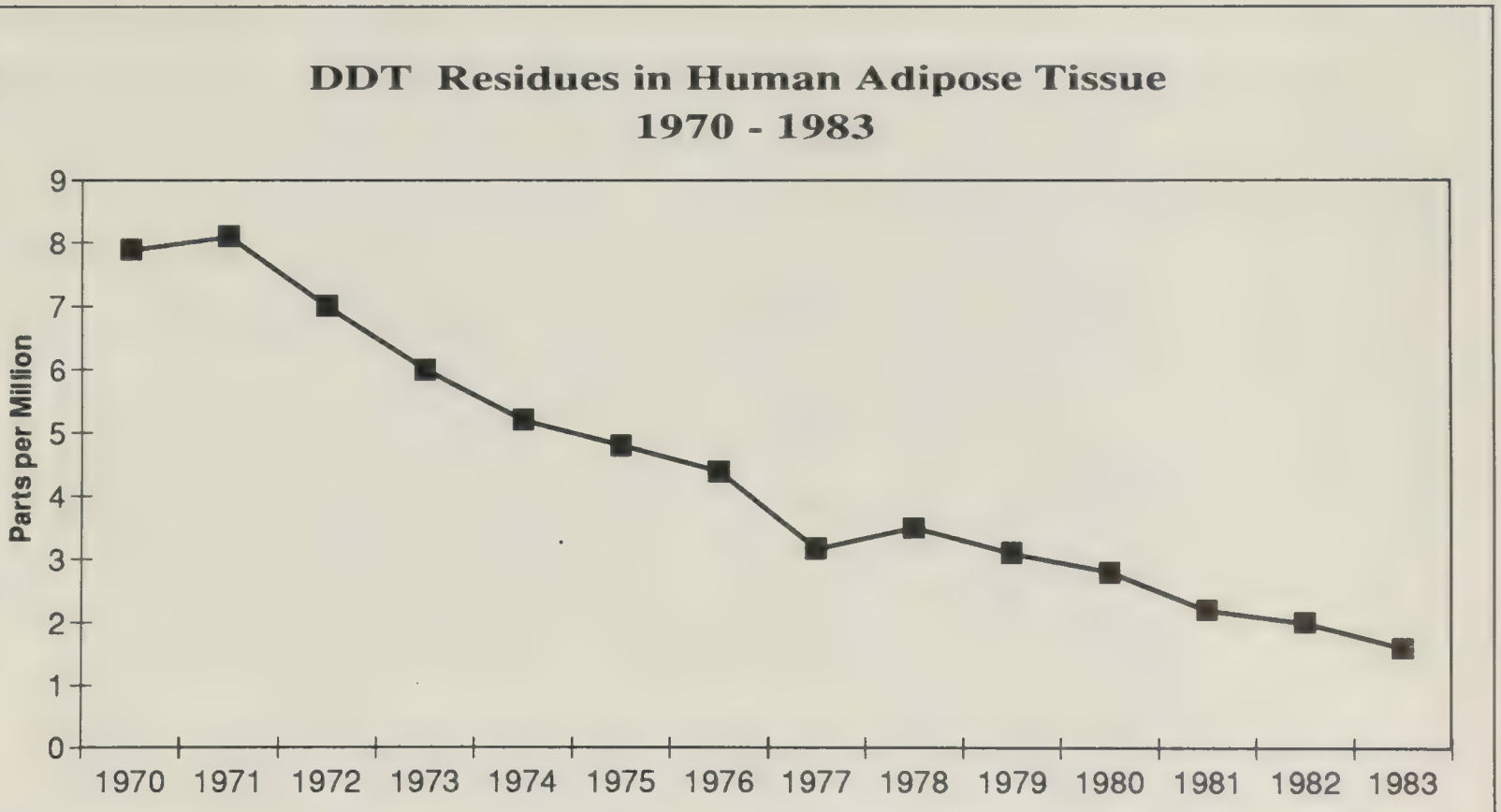
- Crop rotations that mitigate weed, disease, insect and other pest problems; increase available soil nitrogen; reduce soil erosion; and reduce risk of water contamination by agricultural chemicals.

- Pest control strategies that are not harmful to natural systems, farmers, their neighbors or consumers; this includes integrated pest management techniques that reduce the need for pesticides by practices such as scouting, use of resistant cultivars, timing of planting and biological pest controls.



Source: U.S. EPA, 1986. Unpublished data from the National Human Adipose Tissue Survey of the National Human Monitoring Program.

Exhibit 6g.5



Source: U.S. EPA, 1986. Unpublished data from the National Human Adipose Tissue Survey of the National Human Monitoring Program.

Exhibit 6g.6

- Increased mechanical/biological weed control; more soil and water conservation practices; and strategic use of animal and green manures.

Sustainable agriculture focuses on an integrated approach to the science and art of farm management. This approach encompasses the whole farm, relying on the expertise of farmers, interdisciplinary teams of scientists, and specialists from the public and private sectors.[13]

Beginning in 1988 the U.S. Congress began funding a research and education program called low-input sustainable agriculture (LISA). In the last four years, 154 projects have been funded. On-farm experiments and demonstrations, along with whole-farm case studies, are combined with laboratory and experiment-station plot studies to form a scientific and practical basis for farmers seeking a profitable transition from chemical intensive practices to sustainable farming systems.[14] Early results indicate that shifting to sustainable farming systems can be as profitable as conventional agriculture, while also addressing environmental concerns i.e., water contamination, wildlife habitat protection and soil erosion control.[15]

An analysis of U.S. farm costs by USDA economists shows that many farmers are using more purchased chemicals than needed for efficient production.[16] The comparison was made between 25 percent of U.S. farms with lowest per-unit production costs and all other farm operations. Production costs included all variable and fixed cash expenses, plus opportunity costs of owned inputs. For corn, wheat, soybeans and rice, the lowest-cost farms spent less on chemicals, but had higher yields. The most notable exception is cotton where the low-cost farms spent 80 percent more for chemicals and doubled the yield. Other expenses on these cotton farms were sufficiently lower to allow them to fit into the low-cost category.

Several issues need to be addressed to encourage U.S. farmers to adopt sustainable farming practices more rapidly. Current farm programs encourage monoculture systems with high yields; sustainable farming practices require more management on the farms; and many farms do not have technical or economically viable alternatives i.e., cotton, fruits and vegetable operations in the South. Many conventional farms have large investments in existing systems and equipment that is not fully depreciated. In addition, the answer also depends on the farm's crop history, soil productivity, previous input use, management ability, weather and a variety of other factors, such as weed and plant population.

The commissioners of agriculture in states like Iowa, Minnesota, Wisconsin, Oregon, Washington, Texas and California have implemented programs to encourage farmers to move toward sustainable farming systems. In Iowa, legislation enacted in 1989 authorizes at least five model-farm demonstration projects across the state. All projects are intended to implement integrated, efficient farm management, but each will be tailored to address special problems or characteristics of its region. For example, a project in southeast Iowa will focus on conservation tillage; another in the south-central part of the state will focus on forage management. In total, nearly 200 farms will participate in the demonstration program, and an aggressive information program is intended to reach nearly 140,000 farms.[17] (See also the agriculture section of Chapter 4.)

International Cooperation. The United States is taking additional steps to protect public health and the environment from adverse effects of pesticides worldwide. The United States is providing technical assistance to other countries in designing and improving their own regulatory infrastructures. To promote the trade of safe agricultural commodities, the U.S. government has become increasingly involved in efforts to minimize differences between U.S. standards and those of other countries without compromising the safety of the U.S. food supply. This activity will involve identifying and reconciling differences in testing requirements, protocols and risk assessment procedures. The United States also recognizes the importance of promoting the international exchange of information. In this respect, the United States is committed to carrying out the Prior Informed Consent procedures as set out in the London Guidelines for the Exchange of Information on Chemicals in International Trade.

Toxic Industrial Chemicals

Industrial chemicals—metals and metal salts, organic solvents, plastic polymers, fertilizers, acids and bases, among many others—are ubiquitous in modern commerce. Most synthetic chemicals in use in the United States were introduced before the advent of federal environmental protection laws. Relatively few industrial chemicals have been fully tested to determine whether they pose a threat to human health or the environment. The toxicity of others, such as lead, has been known to some extent for a long time; as this understanding has grown, it has been accompanied by increasingly stringent regulation.

Regulatory Authorities

The Toxic Substances Control Act (TSCA) was enacted in 1976 to allow informed decisions to be reached about use of potentially toxic chemicals, preferably in advance of their commercial distribution and use. TSCA gives the federal government broad powers to require testing for chemical risks and extensive regulatory power to prevent or control the manufacture of chemicals that pose unreasonable risks. (Some chemicals are exempt from TSCA authority but fall under the jurisdiction of other federal laws; these include tobacco, nuclear materials, munitions, food additives, drugs, cosmetics and substances used solely as pesticides.) Like FIFRA, TSCA decisions involve the balancing of estimated risks against projected benefits.

Under the statute, anyone who plans to manufacture or import a new chemical substance must notify the government 90 days before doing so. The notice must be accompanied by descriptions of exposures and releases associated with manufacture, processing, use and disposal. Although any available test data must also be submitted, TSCA does not require testing prior to marketing. The government may impose restrictions on the chemical if the producers want to market the chemical; these may include the development of test data needed to assess the risks. However, if a potential risk is identified during the notice review period, the government may regulate the manufacture, processing, use and disposal of the new substance and/or specify handling and use requirements.

Since 1979, more than 18,000 new chemical Premanufacture Notices (PMNs) have been submitted for government review. Based on government concerns identified during these reviews, more than 700 chemicals were withdrawn by the submitters. Use or production of an additional 500 chemicals was permitted only under certain conditions or was restricted pending development of additional test data. Four chemicals were banned, and industry agreed voluntarily to test 350 new substances.

In contrast to the premanufacture review program, the regulation of existing chemicals under TSCA is difficult, requiring several years of analysis in order to promulgate rules. As a result, very few chemicals that were in use prior to enactment of TSCA have yet been regulated under the law. Significant action against toxic substances have included the following:

- There have been extensive efforts, in part required by specific language in TSCA, to limit exposure to asbestos in schools. The first regulations to reduce asbestos exposure were issued under the National Emission Standards for Hazardous Air Pollutants (NESHAPS), as authorized by the Clean Air Act. Some asbestos-containing products were banned in 1977 by the federal Consumer Product Safety Commission under the Consumer Product Safety Act (CPSA). New commercial uses of asbestos have been banned in the United States, as have a number of older uses. Rigorous programs have been initiated to locate, manage in place and remove if necessary, asbestos-containing materials in schools and to strictly limit workplace exposure to asbestos. These programs have been carried out under regulations promulgated by EPA and the Occupational Safety and Health Administration (OSHA).

- In addition to the elimination of lead from gasoline, the use of lead in paints was virtually banned in 1977 under the CPSA by setting a very low (0.06 percent) lead content standard. This standard applies to paints used in residences, schools, hospitals, parks, playgrounds and public buildings; it is intended to provide increased protection to young children. A government lead strategy was announced in early 1991 to further reduce exposure to lead from a variety of sources.

- The United States banned use of chlorofluorocarbons (CFCs) as nonessential aerosol propellants in 1978, and began a ban and phaseout of most other uses of CFCs in 1989 as part of the Montreal Protocol (discussed in the climate change and stratospheric ozone depletion section of this chapter).

During the last two decades, U.S. scientists have determined that concentrations of some toxic air pollutants are often much higher indoors than outdoors. These pollutants include formaldehyde and combustion products such as carbon monoxide, nitrogen oxides, particulates and volatile organics. Since humans spend more time indoors, the human health risks of this indoor pollution may be substantial. The Clean Air Act and other federal laws provide some authority to investigate sources, health effects and control strategies, and to educate the public as to how to reduce exposure to indoor air pollutants. Recent amendments to the Federal Hazardous Substances Act authorize the development of new regulations to clarify requirements for labeling products that contain substances posing chronic hazards such as cancer, neurotoxicity and reproductive toxicity.

Issues in the Control of Toxic Chemicals

New approaches that focus on pollution prevention are being undertaken in order to achieve more rapid and effective changes. Key elements of these new approaches are: making useful information available to all parties involved including communities, workers and industrial management; challenging industry to make substantial voluntary reductions in toxic chemical generation; revitalizing government programs to control toxic substances by developing a priority system for screening and testing chemicals; and

educating consumers so that they can make purchasing decisions that will encourage manufacturers to use fewer and less toxic substances in their products.

In recent years, pollution prevention has moved to the forefront among the options being pursued in the United States for improved management of toxic chemicals as well as hazardous wastes.[18] The Pollution Prevention Act of 1990 calls pollution prevention a "national objective" and declares that "source reduction is fundamentally different and more desirable than waste management and pollution control." The act establishes, as national policy, a hierarchy of preferred methods for dealing with pollutants:

First, pollution should be prevented or reduced at the source wherever feasible. Pollution that cannot be prevented should be recycled in an environmentally safe manner. In the absence of feasible prevention or recycling opportunities, pollution should be treated. Disposal or other release into the environment should be the last resort.[19]

Improving Access to Toxic Chemical Information. As noted earlier, the enactment in 1986 of the Emergency Planning and Community Right-to-Know Act (EPCRA) was an unprecedented advance in environmental legislation in empowering communities with the right to know the nature and extent of toxic chemicals to which they are being exposed, and in assembling this information in usable form on an annual basis. The information made available to the public as a result of this law has led to substantial pressure on industry to reduce toxic chemical releases.[20]

A major feature of EPCRA has been the annual reporting of toxic releases and transfers through the Toxics Release Inventory (TRI), an initiative that originated with programs at the state level in New Jersey and Maryland. The TRI now contains information from some 20,000 facilities on more than 300 chemicals.

The TRI data base is essentially a record of accidental as well as routine toxic chemical releases by manufacturing facilities to the environment. Already, the TRI is being used widely by industry, the states and environmental groups as an annual scorecard for prevention efforts. For example:

- Major corporations are using the TRI to measure the success of their existing prevention efforts and to set future goals.

- Several states have used the TRI as the basis for legislation. Beginning September 1, 1991, TRI facilities in Oregon must file toxics use-reduction plans with the state. The law's aim is to reduce or eliminate the use of toxic substances in the workplace. Maine requires pollution reduction programs for all toxic chemicals. Companies in Maine covered by the TRI must reduce the amount of TRI chemicals they use by 10 percent by 1993, 20 percent by 1995 and 30 percent by 1997.

- TRI data have also been extensively analyzed by environmental organizations to evaluate prevention programs at specific facilities. The non-profit National Institute for Chemical Studies, for example, has created a scorecard out of TRI data for the large chemical industry in Kanawha Valley, West Virginia.

The current TRI data base will include new requirements because of the Pollution Prevention Act of 1990, which requires that information be collected on how pollutant reductions are being achieved. The TRI is expected to serve as a major stimulus to effective, measurable reductions in releases of chemicals, and a model for other countries seeking concrete environmental results through the persuasive power of information.

Encouraging Voluntary Industry Response. In light of increased community involvement through information access, consumer interest in less toxic products, and industrial concern with limiting liabilities and enhancing its public standing, substantial environmental benefits may be expected in the future through voluntary industry responses to new initiatives. The Environmental Protection Agency recently asked nine companies representing 40 individual facilities to submit plans to reduce air emissions of several toxic pollutants, including butadiene, a chemical suspected of causing cancer. The response was uniformly positive; the nine companies contacted have submitted plans pledging reductions of more than 80 percent overall of specified toxic emissions within one to three years.

Federal agencies are also developing voluntary safety standards to improve the efficiency of wood stoves and gas appliances that contribute pollutants to both indoor and outdoor environments. Several state and federal agencies are involved in reducing emissions of volatile organic compounds from consumer products.

One major objective of the National Pollution Prevention Strategy, published in February 1991, was to set forth a number of voluntary programs for various industries to achieve specific objectives in pollution prevention within a reasonable time.[21] This strategy includes a major initiative to attain reductions in emissions of 17 Toxics Release Inventory chemicals by 33 percent by the end of 1992 and by 50 percent by the end of 1995, using the 1988 TRI data as a base. The 17 pollutants were selected based on health and ecological risk, limitations of waste treatment in reducing those risks, potential for multiple exposures or cross-media contamination, and technical or economic opportunities for prevention.

TOXICS RELEASE INVENTORY RESULTS

The Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) requires facilities with 10 or more employees that manufacture, process or use more than specified ''threshold'' amounts of any of some 320 listed toxic chemicals to estimate annually the total amount of these chemicals that they release into the environment—either accidentally or as a result of routine plant operations—or transport as waste to another location. In addition, Section 313 of EPCRA requires EPA to establish a Toxics Release Inventory (TRI) that makes this information available to citizens through a publicly accessible database as well as through other means.

Information from the TRI reveals that in 1989 a total of 2.57 thousand-million kilos of toxic chemicals were released: 1.08 thousand-million kilos were emitted into the air; 540 million kilos were injected into underground wells; 85 million kilos were released directly into U.S. rivers, lakes, streams and other bodies of water; and 220 million kilos were placed in landfill disposal sites.* An additional 248 million kilos were transferred to municipal wastewater treatment plants, and 412 million kilos were transferred off-site to other treatment and disposal facilities. (See Exhibit 6g.7.)

These TRI numbers represent reported total releases; they are not indicators of direct human or environmental exposure to these chemicals. Many environmental releases do not result in exposure, since the discharges may be transformed, neutralized, diluted or isolated by their location from human populations or environmental systems. On the other hand, some transformations lead to byproducts of greater risk than the original releases. The circumstances and characteristics of each release are different.

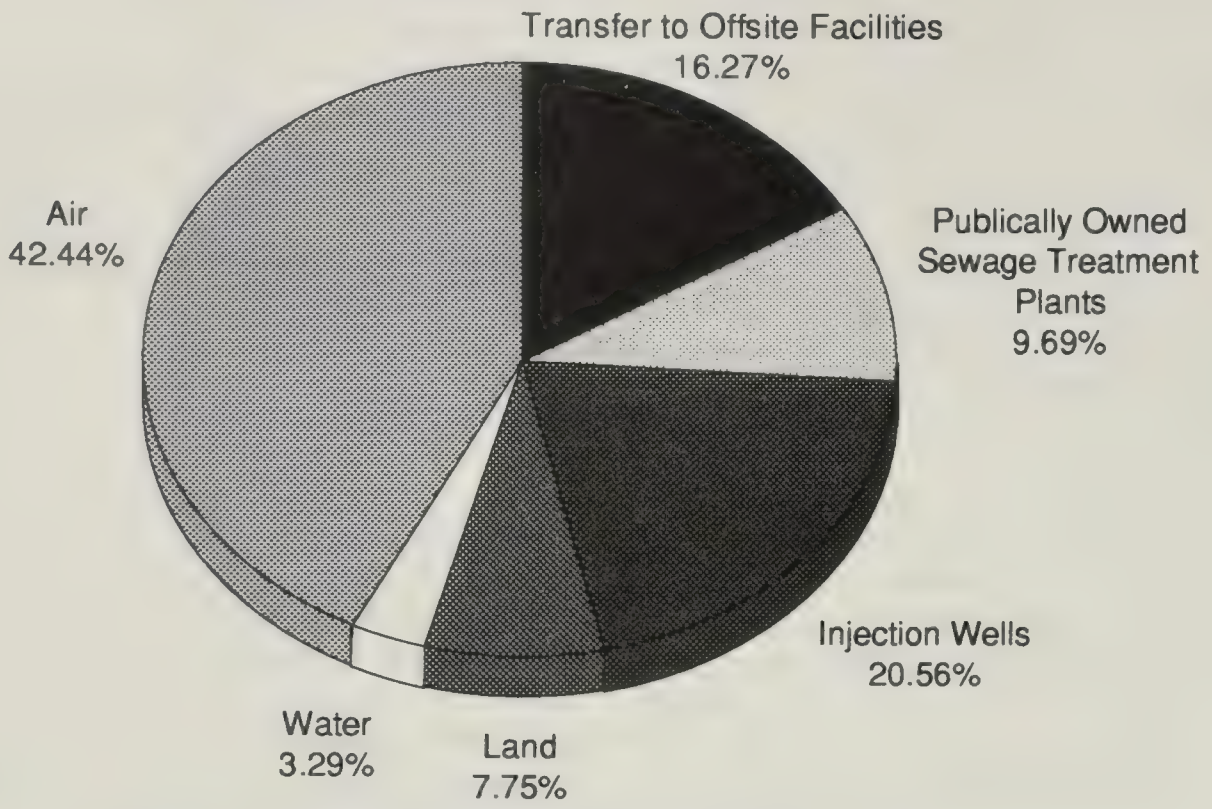
The reported releases and transfers of TRI-listed chemicals for 1989 reflect an overall reduction of 18 percent (590 million kilos) from those reported in 1987. Estimated air releases, which account for 42 percent of all releases and transfers, declined by eight percent (95 million kilos); the amount released into water bodies declined by 54 percent and the amount released to land declined by 39 percent. (See Exhibit 6g.8.)

Although the declines in releases to water and land appear significant, approximately half of these apparent declines may be attributable to improved reporting by facilities in 1989. Other evidence suggests that real decreases did occur. First, 2,000 more facilities (a 15-percent increase) reported for 1989 than for 1987; second, industrial production by the majority of industries reporting increased by two to nine percent from 1987 to 1989.

For many companies, the TRI data they and others report can provide an impetus to consider changes in the mix of materials and processes used during manufacturing. The TRI has also been extensively used by citizens' groups and government agencies to assess the potential health and environmental risks posed by chemical emissions, and to press for reductions where the opportunities are the greatest. Future reports will help to determine the success of pollution prevention initiatives. Already the TRI is fast becoming one of the most powerful tools for government and citizens to use in reducing toxic chemical emissions.

*Source: U.S. Environmental Protection Agency, *Toxics in the Community: National and Local Perspectives: 1989* (September 1991).

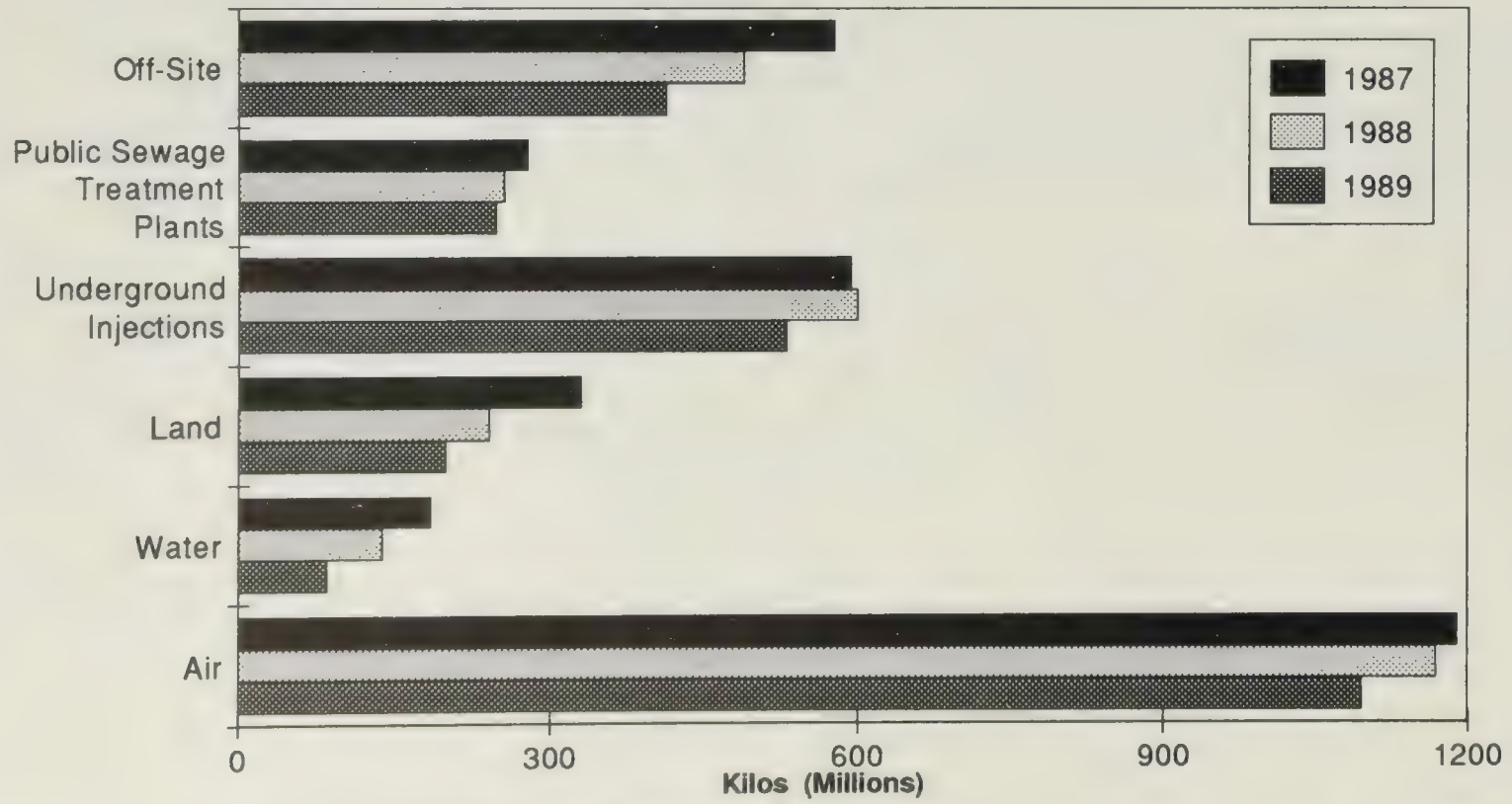
1989 Toxics Release Inventory:
Where the 2.57 Thousand-Million Kilos Went
1989 Releases and Transfers



Source: U.S. EPA, *Toxics in the Community*, September 1991.

Exhibit 6g.7

Toxics Release Inventory:
Reported Toxics Releases and Transfers, 1987-1989



Source: U.S. EPA, *Toxics in the Community*, September 1991.

Exhibit 6g.8

Since the targeted chemicals are included on the TRI, reductions in their releases can be measured in each year's TRI reports. The government has already contacted several hundred companies that reported releases of the targeted chemicals in the past. A high degree of cooperation is expected from these companies in making voluntary commitments to reduce releases and in developing pollution prevention plans to carry out their commitments. This program has set the stage for further cooperation between government and industry to help battle some of the pollution problems that face the nation. As of November 1991, over 400 companies had committed to an overall reduction of 151 million kilos by 1995.

A second objective of the Pollution Prevention Strategy is to provide guidance and direction for EPA's efforts to incorporate pollution prevention into its own regulatory and non-regulatory programs. This strategy also highlights the need for federal agencies to develop specific strategies for pollution prevention in other sectors, such as agriculture, energy and transportation. "Sector" strategies for pollution prevention should serve as the approach of choice for improving environmental quality across all sectors of society. A coordinated approach by government, industry and educational institutions in the development, accreditation and dissemination of pollution-prevention-related activities is essential to achieve this objective.

Revitalizing Government Toxic Substance Programs. Toxic substance programs are being revitalized at all levels of government with a new approach that emphasizes substitution of toxic products with less toxic substances or with non-toxic alternatives. In a number of states, "toxics use-reduction" laws are being passed, requiring future reductions in the use of toxic materials. For example, Louisiana has a law mandating a 50-percent reduction in toxic air emissions by 1994. Massachusetts and Oregon lawmakers worked closely with public interest groups and industry to enact similar laws.

At the federal level, the current legal authorities remain very broad, offering the government many ways to stimulate industrial pollution prevention activities. A major initiative is underway to apply TSCA and related programs to more effectively protect human health and the environment from undue exposures to toxic substances. The United States is examining possibilities for more vigorous use of existing powers to control existing chemicals. The federal programs are expected to move away from single chemical regulatory actions and towards multimedia, multichemical approaches involving regulatory and non-regulatory actions that will be coordinated with state government programs to a much greater degree than before.

The new lead control strategy is one example of this approach. In early 1991 the federal government announced a comprehensive, multimedia strategy to reduce American's exposure to lead with particular emphasis on reducing the risk to children. The government's plan calls for proposed regulatory programs to decrease lead levels in drinking water and in ambient air near large stationary sources such as lead smelters and refineries; stepped-up enforcement actions against facilities violating lead standards; and investigations into the location of lead "hot spots." Lead also is among the 17 substances targeted for voluntary reductions in the industrial toxics reduction project mentioned above.

LEAD—STILL MORE TO DO

Lead is a highly toxic metal; when ingested by humans it produces a range of adverse health effects, particularly in children and fetuses. Effects include nervous and reproductive system disorders, delays or permanent impairment in neurological and physical development, reduction in mental capacity, other behavioral changes and hypertension.* Adverse health effects have been found at increasingly lower blood lead levels.

Lead pollution has declined throughout the United States over the past 20 years as measured in the air and water, in people and in wildlife. The precipitous drop in lead air pollution that resulted from virtually eliminating lead from gasoline in the United States is often cited as one of this country's most successful regulatory efforts. In 1991 the U.S. Environmental Protection Agency reported that average lead concentrations in the air dropped 87 percent during the 1980s; air emissions decreased 96 percent from 1970 to 1989.

This success, combined with removal of lead-soldered food cans from domestic production and banning of lead-containing paint for interior use, has made lead a lower health-risk problem in the United States. EPA estimates that the population of U.S. children with elevated blood lead levels (levels over 10 ug/dl) dropped from 91 percent between 1976 and 1980 to 15 percent in 1990. Nevertheless, because lead is so toxic and so many still are exposed to it, the U.S. government in 1991 developed an ambitious new strategy for further reducing lead exposures.

The strategy focuses on the three major sources contributing to lead exposures, particularly among children: (1) deteriorating lead-based paint, (2) urban soil and dust (contaminated mainly by lead-based paint and gasoline), and (3) lead in drinking water. Less important sources (some of which may be significant in certain localities) include vehicle emissions, smelters, hazardous waste sites and food. Actions will be taken to:

- Identify ``hot spots.'' Locate and map the regions, cities, neighborhoods and homes having high ambient lead concentrations or persons with elevated blood lead levels, and their sources.
- Develop and disseminate methods for state and local governments and property owners to correct problems from lead already deposited in their environment. Pilot projects are underway in Boston (Massachusetts), Baltimore (Maryland) and Cincinnati (Ohio) to remove lead-contaminated soil and dust and then to evaluate the results.
- Reduce future exposures through a pollution-prevention program that limits or eliminates uses of lead wherever possible, and cut remaining industrial releases of lead to the environment in half by 1995.
- Further control lead contamination in water, air and elsewhere in the environment by setting performance standards and using other regulatory approaches.
- Encourage environmentally sound recycling of batteries and other spent lead products.
- Educate the public about health risks from lead, how to reduce or avoid exposure, and how to prevent the introduction of additional lead into the environment.
- Increase and coordinate enforcement of lead pollution control strategies in all relevant federal environmental protection programs.
- Conduct research needed to locate and assess the most serious lead risks, and develop additional methods to reduce them.

*For a review of the known human health effects of lead, see: U.S. Department of Health and Human Services, Centers for Disease Control, U.S. Public Health Service, *Childhood Blood Lead and Environmental Status Report,* (Washington, D.C.: 1986); and U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, *The Nature and Extent of Lead Poisoning in Children in the U.S.: A Report to Congress,* (Washington, D.C.: 1988).

International efforts for revitalization have also had a profound effect on regulatory actions within the United States. The Screening Information Data Set (SIDS), for example, divides the responsibility for compiling data on various high-volume chemicals in order to determine preliminary risk decisions among the Organization for Economic Cooperation and Development countries.

Consumer Information. Recent amendments to several federal laws provide for a range of non-regulatory options to reduce pollution, with emphasis on informing the consumer of potential hazards from exposure to toxic substances. Decisions made by informed consumers can have a profound effect on the types of products that are manufactured and distributed. Providing information to the consumer is a key link in improving the performance of the marketplace when product quality may depend on technical information that is difficult for the consumers to obtain.

One important means of providing environmental information is product labeling. Various proposals would have product labels state whether the product contains toxic substances or contains ingredients harmful to the environment; others would affix a seal or symbol to environmentally benign products. This issue is currently receiving attention from several public and private groups, including a number of states, federal agencies and two private certification programs.

Endnotes:

1. Council on Environmental Quality, Toxic Substances, (Washington, D.C.: U.S. Government Printing Office, 1971).
2. "Special Message to Congress Proposing the 1971 Environmental Program," in *Public Papers of the Presidents, Nixon, 1971* (Washington, D.C.: U.S. Government Printing Office, 1972).
3. The environmental problems and policy debates that led to the development and passage of these two laws are reviewed in John C. Whitaker, *Striking a Balance: Environment and Natural Resources Policy in the Nixon-Ford Years* (Washington, D.C.: American Enterprise Institute for Public Policy Research, 1976).
4. Other federal laws that provide additional federal regulatory authority over toxic substances include the Federal Hazardous Substances Act (FHSA), the Consumer Product Safety Act (CPSA), and for toxic substances that become hazardous wastes, the Resource Conservation and Recovery Act (RCRA), which is discussed in the wastes section of this chapter.
5. Personal communication with Jim Jones, U.S. Environmental Protection Agency, Office of Pesticide Programs.
6. U.S. Environmental Protection Agency, *EPA's Pesticide Programs* (Washington, D.C.: Environmental Protection Agency, 1991), p. 2.
7. Council on Environmental Quality, *Annual Report on Environmental Quality* (Washington, D.C.: 1989).
8. Ibid.
9. E.M. Thurman, D.A. Goolsby, M.T. Meyer, and D.W. Kolpin, "Herbicides in Surface Waters of the Midwestern United States: The Effect of Spring Flush," *Environmental Science and Technology* vol. 25, no. 10 (1991): pp. 1,794-1,796.
10. Ibid.
11. U.S. Environmental Protection Agency, Pesticides in Groundwater Data Base, 1991.

12. U.S. Environmental Protection Agency, *Environmental Progress and Challenges: EPA's Update* (Washington, D.C.: Environmental Protection Agency, August 1988), p. 134.

13. *Alternative Agriculture* (National Academy Press, 1989).

14. U.S. Department of Agriculture, *Progress Report of LISA,* 1991.

15. *Agriculture Policy and the Transition to Sustainable Agriculture* (World Resources Institute, 1991).

16. W.D. McBride and H. El-Osta, "Do Efficient Producers Use More Chemicals?" Situation Outlook Report, AFO-37 (U.S. Department of Agriculture, Economic Research Service, May 1990).

17. Council on Environmental Quality, *Environmental Quality: the Twentieth Annual Report of the Council On Environmental Quality* (Washington, D.C.: U.S. Government Printing Office, 1990), p.242.

18. President George Bush articulated this viewpoint in October 1990 when he noted, "Environmental programs that focus on the end of the pipe or the top of the stack, on cleaning up after the damage is done, are no longer adequate. We need new policies, technologies and processes that prevent or minimize pollution—that stop it from being created in the first place."

19. Pollution Prevention Act of 1990, Section 2(b).

20. EPCRA, the Emergency Planning and Community Right-to-Know Act, was enacted in October 1986 as Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA); thus it is variously referred to as EPCRA, or the Community Right-to-Know Act, or Title III of SARA. The United States Code citation is 42 U.S.C. §§11001-11050.

21. U.S. Environmental Protection Agency, "U.S. Environmental Protection Agency Pollution Prevention Strategy," (1991).

—H—
Wastes

Overview

The growth of solid and hazardous waste generation in the United States has been linked to the expansion of the U.S. industrial and agricultural sectors over the last 50 years. While this expansion produced a broad array of consumer goods and jobs, it was generally not accompanied by federal or state programs to manage waste or to reduce its generation. During the past decade, greatly increased federal and state environmental protection efforts have brought about significant improvements in the management of waste, and in particular, hazardous waste. These efforts have resulted in a greater level of protection for human health and the environment of the nation, greater and more accurate information on activities that generate waste, increased public awareness and participation, and a clearer recognition of the amount of work remaining to be done. While significant progress has been made, important challenges lie ahead.

Per capita solid waste production in the United States is greater than any other country in the world. Although per capita waste generation has increased, the rate of growth has declined during the last decade. In 1970, U.S. municipal solid waste production was 122 million tons, or almost 1.5 kilos per person per day; by 1980, it was 1.63 kilos; by 1988, that figure had reached 1.8 kilos. Collectively, this nation now produces more than 180 million tons of trash and garbage per year, most of which is placed in municipal landfills. Meanwhile, the number of landfills open to receive these wastes has declined from approximately 20,000 in 1978 to less than 6,000 today; half of these will be full by the mid-1990s.[1]

Increased generation of solid waste during the past 30 years was accompanied by similar trends in the generation of various types of hazardous waste. During most of that period, there was no nationally accepted definition or list of what substances constituted hazardous wastes, nor was information compiled at the national level on what types or quantities of hazardous wastes were generated or disposed of annually. In fact, prior to 1976, federal and state governments exercised little or no regulation of hazardous waste disposal. As a result, hazardous waste was often disposed of in an unsafe manner, most commonly in municipal landfills and unlined lagoons, or was simply dumped on the ground or into surface waters.

Driven originally by concerns about the potential risks from widespread contamination of soil and water by mercury, polychlorinated biphenyls (PCBs) and pesticide residues, Congress enacted several laws during the 1970s that required monitoring and control of hazardous wastes.[2] The most important of these statutes was the Resource Conservation and Recovery Act (RCRA) of 1976, which requires "cradle to grave" management of hazardous waste. RCRA directed the U.S. Environmental Protection Agency (EPA) to develop a definition and listing of hazardous wastes; to regulate the generation, storage, transportation and treatment of such wastes; and to require persons or organizations involved in the treatment, storage or disposal of hazardous wastes to report on the types and amounts of such wastes being handled on an annual basis. RCRA also calls for the reduction or elimination of hazardous waste generation. This strategy is referred to as "pollution prevention," and in this context as well as others it has become a priority for the federal government in the management of waste.

In addition to its hazardous waste management program, the United States has other "waste" programs in place. (See Exhibit 6h.1.) These programs address the cleanup of abandoned hazardous waste sites, municipal solid waste generation and its safe disposal, the safety of underground storage tanks and the management of radioactive wastes. This section discusses some of the many programs the federal and state governments have put in place to

address waste problems in the United States. (Radioactive wastes are addressed in the energy section in Chapter 4.)

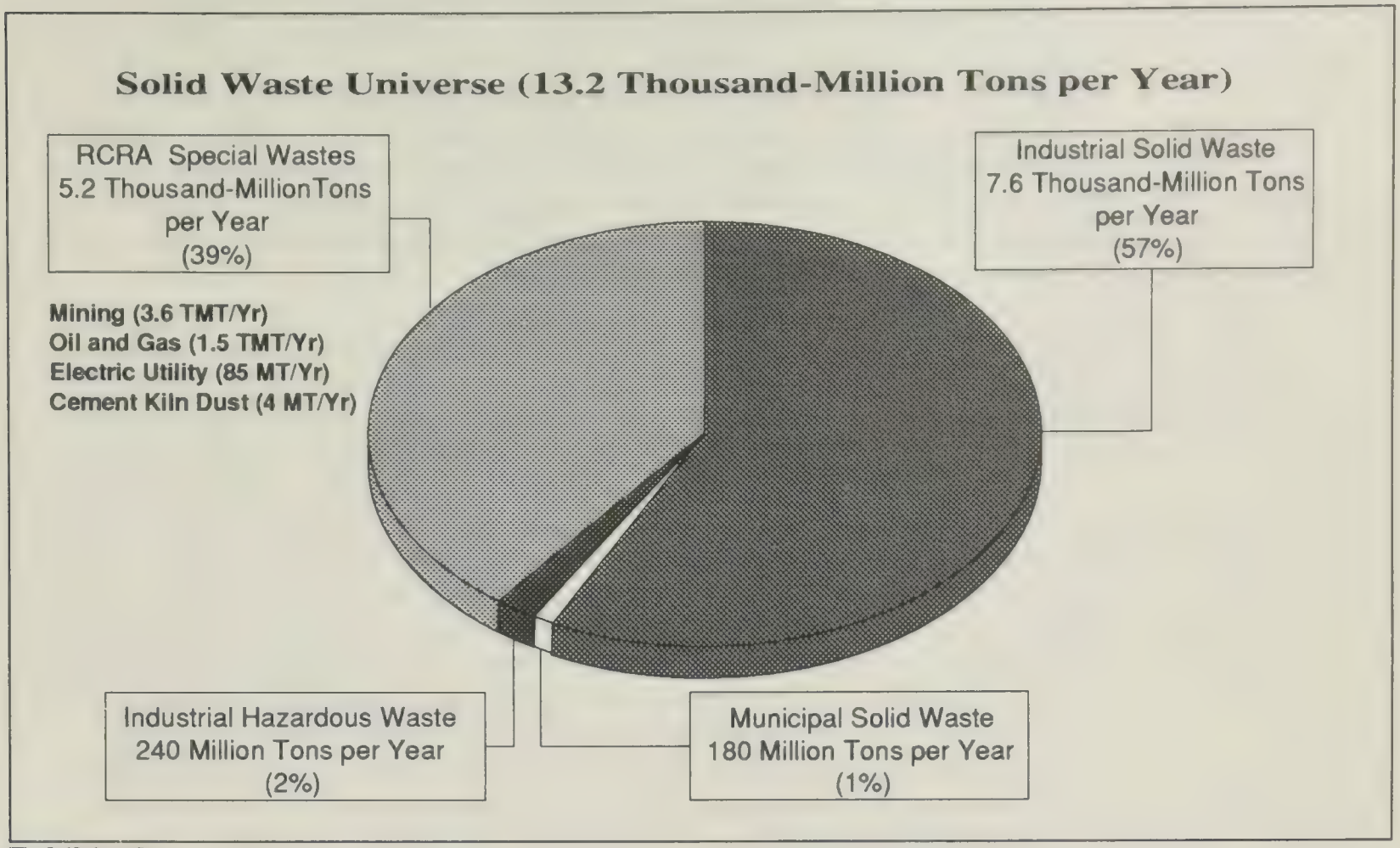


Exhibit 6h.1

Hazardous Waste Generation and Management

The RCRA program (as amended by the Hazardous and Solid Waste Amendments of 1984) prescribes a number of controls over facilities that transport, treat, store and dispose of hazardous wastes. RCRA regulations define a waste as hazardous if it exhibits a "characteristic" based on ignitability, corrosivity, reactivity or toxicity, or if it is formally "listed" as a hazardous waste by EPA. Under RCRA, the United States has developed strict technical standards for construction of hazardous waste landfills, such as double liners, and leachate detection and collection systems, and has issued regulations prohibiting or restricting disposal of several types of hazardous wastes (such as flammable or corrosive liquids) on land.

The total amount of RCRA hazardous industrial waste generated in 1987 was 240 million tons.[3] Currently, the RCRA program regulates the management of hazardous waste by more than 15,400 large volume generators and more than 210,000 small quantity generators. (Small quantity generators are defined as those producing greater than 100 kilograms but less than 1,000 kilograms of hazardous waste per month, and may be eligible for exemptions from certain requirements). Roughly two percent of the hazardous waste generators account for nearly 98 percent of the hazardous waste reported as being generated in the United States. Moreover, 90 percent of U.S. hazardous waste was generated by only 50 of the largest generators.

The federal government tracks hazardous waste from "cradle to grave" through the use of a manifest. A manifest (analogous to consignment notes in

other countries) must accompany hazardous waste shipments from their point of generation to their place of ultimate treatment, storage or disposal. The manifest contains the name and identification number of the generator, transporter(s) and facility where the waste is to be treated, stored or disposed, as well as waste descriptions that comply with transportation regulations. Quantities of waste being transported are identified. The address of the treatment, storage or disposal facility to which the generator is sending waste is included. Moreover the generator must certify, on the manifest, that: (1) the generator has a program to reduce the volume and toxicity of waste; and (2) the method chosen to treat, store or dispose the waste is the most practicable currently available that minimizes the risk to human health and the environment.

Requirements under RCRA are implemented through issuance of permits for inspections of facilities, and through civil and criminal enforcement. The goals of the RCRA Enforcement Program are to ensure that RCRA's regulatory and statutory provisions are met, and to compel characterization and remediation of hazardous waste releases at treatment, storage and disposal facilities. To properly oversee such a large universe of facilities, federal and—where the authority has been delegated to them—state officials inspect facilities and take enforcement action to return facilities to compliance and to deter potential violators. In fiscal year 1989 alone, the RCRA enforcement program conducted nearly 2,000 inspections of treatment and storage facilities, and assessed more than $6 million in RCRA penalties.[4]

States have taken on an increasingly active role in hazardous waste regulation as EPA has delegated authority to them to implement major portions of RCRA. EPA periodically reviews delegation authorities to ensure that these states are satisfying federal guidelines. As of September 1991, EPA had delegated program responsibilities to all but four states. At least 14 states, including Massachusetts, Oregon, Illinois and New Jersey have passed legislation to limit the use of toxic substances and/or reduce hazardous waste generation. Some states have set standards that are equivalent to, or even more stringent than, the standards set forth in federal law. In many cases, states have adopted innovative ways to control waste generation and management. For example, Connecticut and Minnesota both have a hazardous waste tax; Minnesota's tax is based on tons of waste generated.[5] Rhode Island has a program that encourages and rewards achievements in waste reduction through technical assistance programs that work closely with trade associations and productivity- and quality-improvement organizations.

Issues in Hazardous Waste Generation and Management

A fundamental issue confronting government agencies in the United States is the relative importance of hazardous waste as an environmental concern. As noted in the overview of this chapter, in the fall of 1990 EPA's Science Advisory Board published a report ranking the principal nationwide risks to human health and the environment.[6] Hazardous waste contamination was conspicuously absent from the list of top-ranked risks, in part because existing regulatory programs have reduced such risks. The Board's conclusion that hazardous wastes currently present low to medium environmental risks contrasts sharply with the public's belief, as voiced through affected populations, interest groups and through Congress, that the United States should continue to expand hazardous waste controls. Complicating the placement of hazardous waste in the hierarchy of environmental risks is the fact that reliable data on hazard and exposure are limited and are subject to constant re-interpretation. Furthermore, data and methodologies for valuing the benefits of regulation against their costs are sparse, or in some cases, non-existent.

Another topic of public debate is how to allocate responsibility for administering the country's hazardous waste program. Although federal, state and local governments work with each other to avoid overlaps, their respective roles are not always clearly defined and can be a source of friction. Although federal funding has increased, states have less incentive to apply for the necessary authorities if the federal government does not fund all the added administrative costs.

The federal government is grappling with the need to fine-tune the RCRA program to address wastes that exhibit moderate toxicity but are generated in large amounts. For example, the mining industry generates 1.5 thousand-million tons of waste annually, all of which are currently excluded from federal hazardous waste regulation, but are regulated under the Clean Water Act and the Clean Air Act in addition to being generally heavily regulated at the state level.[7] The cumulative toxicity of these wastes, generated in such large amounts, may warrant at least some additional measure of regulatory oversight under federal hazardous waste law. Therefore, the government is considering a tailored regulatory program for mining waste that relies on existing state programs.

Finally, a recent comprehensive evaluation of the RCRA program, undertaken by federal and state officials, determined that more could be done to establish clear priorities, target enforcement efforts, develop more and better environmental data, develop clear and concise regulations, and emphasize waste minimization.[8] The United States is moving forward to implement the key recommendations identified in the report.

Waste Export. In 1984, amendments to RCRA set forth new regulatory controls over export of hazardous waste.[9] As a result, the United States has one of the most stringent waste export programs in the world. U.S. companies were forbidden to export hazardous waste without first notifying the receiving country and obtaining that country's formal consent. An acknowledgement of the receiving country's consent must now accompany the hazardous waste manifest. Existing law thus enables the United States to investigate and bring civil and/or criminal actions against those who engage in illegal waste export.

The federal government collects annual statistical reports from waste exporters. These statistical data indicate that less than one percent of the total amount of hazardous waste generated within the United States is exported. In 1990, the U.S. exported approximately 139,000 tons of hazardous waste out of the total 240 million tons generated.[10] Over 95 percent of that amount stayed within North America: approximately 68 percent was sent to Canada and 28 percent to Mexico. The majority of the remaining hazardous waste was exported to other nations within the Organization for Economic Cooperation and Development.

The United States recently signed the Basel Convention, which provides the framework for an international system of waste export controls. As required by the U.S. Constitution, the Senate must consent to ratification of the Basel Convention. On May 13, 1991, President George Bush transmitted the Basel Convention to the Senate, along with a request for consent to ratify. Proposed legislation would provide the necessary statutory authority to control transboundary movements of wastes as required by the Basel Convention, and the new authority would enable the United States to control shipments of all wastes subject to the Basel convention, including household wastes and residues from the incineration of household wastes. It would enable the government to stop exports even after the importing country has consented, if the government has reason to believe that a particular shipment will not be managed in an environmentally sound manner.

Waste Minimization. One of the key lessons that the United States is learning from its experience generating, regulating and cleaning up waste is that it is preferable not to generate it in the first place. The nation's hazardous waste problems cannot be cured simply by burying waste in the land, inasmuch as it is possible for even well-regulated land disposal facilities to leak and contaminate groundwater supplies, creating the potential for costly cleanup problems. Expensive treatment methods such as incineration will reduce, but not eliminate, the need for land disposal. Issues of adequacy of the national capacity for treatment, storage and disposal facilities will remain. Relying on waste management regulations, treatment and strict controls on land disposal therefore are an expensive and inefficient way to manage the nation's hazardous waste. Congress, recognizing that the preferred manner of managing waste is not to generate it in the first place, set forth as a national goal the reduction or elimination of hazardous waste. EPA established a "waste minimization" component of its pollution prevention program to help industries and state and local governments make progress in achieving this goal.

The states, industries and non-governmental organizations (NGOs) have also been active in promoting waste minimization and pollution prevention. In recent years, many of the states have enacted their own pollution prevention laws and established technical assistance programs to help industries obtain economic and environmental benefits associated with waste minimization.[11] Companies such as 3M, Polaroid, Northrop and Dow have turned increasingly to measures aimed at reducing their generation of waste, in part because the U.S. regulatory system makes the handling of hazardous waste an extremely costly, complicated business. Instead of focusing exclusively on regulating, treating and disposing the wastes generated by a production process, companies are learning to consider opportunities for waste minimization presented by the entire production and materials management process. Identifying good opportunities for waste minimization requires the cooperation of government, NGOs and industry, as well as technical assistance, public outreach, new training and better data to help measure progress and target efforts.

Hazardous Waste Cleanup

In the late 1970s it became apparent that uncontrolled environmental contamination from hazardous waste sites was a nationwide problem that would require resources and a structure beyond those already committed to RCRA. In 1980, Congress enacted the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), commonly known as the Superfund law. The law directed federal agencies to identify abandoned or bankrupt facilities that presented threats to public health or the environment, and to initiate cleanup actions at those sites. Under the law, a trust fund was established to enable the federal government to clean up the most dangerous hazardous waste sites, as identified by state and federal officials, and to respond to spills and other hazardous waste emergencies. The law, however, holds responsible parties liable for the costs of cleanup and gives EPA a broad range of enforcement authorities to compel private party action. If the government conducts the cleanup, it can seek to recover its costs from the responsible parties through the federal courts.

The Superfund program directed EPA to establish a method for identifying sites from which releases of hazardous substances into the environment had already occurred or were likely to occur. By 1990, federal and state governments had identified more than 33,000 potentially hazardous

waste sites; over 90 percent of these sites have undergone further investigation to determine the nature and extent of the contamination and the need for action. The federal government has determined that 19,000 of these sites will not require action under the federal Superfund. Many state agencies will, however, address these sites under their own state environmental programs. Forty-nine of the 50 states currently have established some type of public-funding mechanism to address these problem sites.[12]

As of September 30, 1991, the Superfund National Priorities List (NPL), which identifies the nation's most serious hazardous waste sites, currently includes approximately 1,245 sites. (See Exhibit 6h.2.) Under the federal Superfund program, EPA takes steps first to minimize environmental risks, and eventually achieve permanent site cleanup. To this end, short-term response actions have been taken at 475 NPL sites in order to control the immediate threats to human health and the environment while long-term cleanup is underway. Long-term work has begun at 550 sites. In addition, response actions have been taken at another 1700 non-NPL sites. These actions were taken to mitigate near-term threats to human health and the environment.

During fiscal year 1991, the federal government agreed to 283 legal settlements with potentially responsible parties to perform or pay for cleanup costs. Those settlements have a value of over $1.4 million. At present, well over half of the cleanup action has been undertaken by the responsible parties. During the 1990 fiscal year, the government recovered $105 million in costs and penalties, as compared with $66.5 million in the prior fiscal year.

In 1986 Congress reauthorized and expanded the Superfund law through the Superfund Amendments and Reauthorization Act, or SARA. The Superfund was originally conceived as a short-term program with a $1.6 thousand-million trust fund. SARA reauthorized the fund's limit at over $8 thousand-million. In 1991, SARA was extended for three more years at an authorization level of $5.1 thousand-million. In SARA, Congress directed EPA to focus more on developing permanent remedies for Superfund sites and less on simply containing hazardous substances at sites. Treatment of hazardous substances is now a major component of the remedies being selected for many sites. Extensive efforts are underway to develop the technologies that will ensure permanent cleanup. Under the Superfund Innovative Technology Evaluation Program, the United States is evaluating new technologies to destroy, stabilize or reduce the volume or toxicity of hazardous substances.

SARA also required the assessment and cleanup of some federally owned facilities which in some instances had for decades improperly treated and disposed of hazardous substances. Virtually every state contains one or more federally owned or operated facilities (such as a military base, storage center, test site or research laboratory) with environmental violations and compliance problems. In response to SARA, federal and state agencies are beginning to address the often complex and expensive task of cleaning up federal facilities.

The creation of Superfund has had effects that go beyond cleanups of NPL sites. Since the passage of CERCLA, many states have enacted their own hazardous waste site cleanup laws. The Superfund liability standard has also provided a powerful incentive for businesses, federal facilities and local governments to properly manage their wastes and to adopt waste minimization programs. In addition, the threat of potential legal liability under Superfund has spurred many businesses, particularly during private property transfers, to conduct environmental audits and to deal with hazardous wastes as well as with other environmental problems.

Assuring public participation in the Superfund process has been an important component of the program. Technical solutions are only part of the issues that must be dealt with at Superfund sites; it is also important for government agencies to communicate the issues being considered to affected citizens and to give those citizens the opportunity to express their concerns and preferences. To provide for community involvement and to help individuals living near National Priorities List waste sites to become better informed, Congress established a special "Technical Assistance Grant" Program to help local citizens become involved in decisions about cleanup strategies. Under this program, EPA makes site-specific grants of up to $50,000 available to qualified community groups for the purpose of hiring independent technical advisors to help them understand and interpret technical information related to a Superfund site.[13] With such understanding, the local community groups are better able to comment on technical matters that are the basis for the federal government's cleanup decisions at the site.[14] To date, 58 such Technical Assistance Grants have been awarded.

Through their experience with the Superfund program, government officials have learned that public participation works best when the public is involved early and continually throughout the process; to do so requires an investment of time by a broad array of governmental staff with technical, enforcement and public affairs expertise. This investment, although sometimes appearing to be expensive, has proven to be cost-effective in many cases. At times, the initiation of a cleanup activity may be delayed by public involvement. However, at sites where the government has involved the citizenry and worked with them both early and frequently, the cleanup process has often been easier, quicker and less expensive than at other sites.

While the Superfund program addresses the cleanup of hazardous waste contamination at abandoned or bankrupt facilities, the RCRA "corrective action" program authorizes the federal government to require owners of hazardous waste sites or operating facilities where hazardous materials have been released to clean up the contamination.[15] Through this program, the government can require a facility regulated under RCRA to assess the nature of the contamination, to perform an in-depth investigation, and to conduct a full cleanup. This cleanup authority can be exercised through enforcement orders or facility permits. Corrective action may be required for contamination that extends beyond the facility boundary. Unlike Superfund, the RCRA corrective action program has no fund with which to finance cleanups. Instead, the entire responsibility for cleanup falls upon the owner/operator of the facility.

Approximately 4,600 hazardous waste management facilities are potentially subject to cleanup under this corrective action program. These facilities vary widely in terms of the threats they pose to human health and the environment: many have relatively minor contamination problems, while some may pose environmental risks comparable to major Superfund sites. The federal government seeks to manage the corrective action program so as to address the "worst sites first." To accomplish this goal, the EPA has developed a system to assess priorities and target facilities with the most serious problems. More than 800 facilities are now in some stage of implementing this corrective action program. This process includes the stages of assessing the problem, studying the feasibility of alternative solutions, selecting the remedy and finally implementing the cleanup itself.

National Priorities List Sites

AS OF SEPTEMBER 10, 1991

NATIONAL TOTALS:
1185 Final NPL (+)
22 Proposed (x)
1207 Total NPL

Alaska	6
Guam	1
Hawaii	2
P Rico	9

Exhibit 6h.2

Issues in Hazardous Waste Cleanup

Abandoned hazardous waste sites are more numerous than anticipated when Superfund was created. Their cleanup is extremely complex and is requiring considerably more time and resources than was first expected. The complexities surrounding Superfund cleanups have various causes. First, many sites have been so heavily contaminated, or the contamination has affected such large areas, that current technology is not always adequate to achieve complete site cleanup. For example, a recent EPA evaluation showed that, in some cases, the pumping and treating of contaminated groundwater is not achieving required reductions in contaminant concentrations, even after several years.[16] In addition, at some sites mining or smelting activities have resulted in extensive lead and arsenic contamination of soils and sediments that will be extremely costly and difficult to clean up. Although resources have been devoted to developing innovative cleanup technologies, the challenge is great and remediation costs are often high.

An important issue facing the government, as well as the private parties responsible for the site work, is how to decide what level of cleanup is appropriate at a particular Superfund site—or "How clean is clean?" The mandate of the Superfund program is to protect human health and the environment from current and potential threats from hazardous waste sites.[17] Since the cost of site cleanups typically increases as cleanup goals become more stringent, the definition of "clean" has implications for the rate at which sites are addressed and for the total public and private expenditures to be allocated for such cleanups.

Other complexities in achieving cleanup relate to enforcement issues. EPA emphasizes an "enforcement first" approach in which responsibility for cleanup of Superfund sites is placed wherever possible on those who contributed to the problem.[18] A strong enforcement approach reinforces the message that responsible parties will be held liable for cleaning up environmental damage. Disagreements have arisen over such issues as the remedy to be employed at the site, as well as over who pays what portion of the cleanup. In addition, some parties identified by the government as responsible have strongly contested that status.

Municipal Solid Waste

Municipal solid waste is generated by households, commercial establishments and public institutions such as schools. As shown in Exhibit 6h.3 below, this waste includes discarded durable goods (e.g., household appliances), containers and packaging, yard wastes and office paper in addition to more typical household wastes such as paper trash and organic garbage. Municipal solid waste is a growing national issue as landfills in many communities are filling up and new sites become increasingly difficult to identify and to open in the face of public opposition; this is sometimes referred to as the "NIMBY" or "not in my back yard" problem.

In 1988, an estimated 180 million tons, or approximately 1.8 kilos per person per day, of municipal solid waste was generated; this total has steadily increased, more than doubling since 1960.[19] Landfills continue to be the dominant waste management technology, but the percentage of waste placed in landfills is declining as the country moves toward the national goal of reducing municipal solid waste by 25 percent through source reduction and recycling. Approximately 73 percent of the waste generated in 1988 was placed in landfills. Incineration (14 percent) and recycling (13 percent) were, respectively, the next most common management practices, reflecting increases since the mid-1980s.

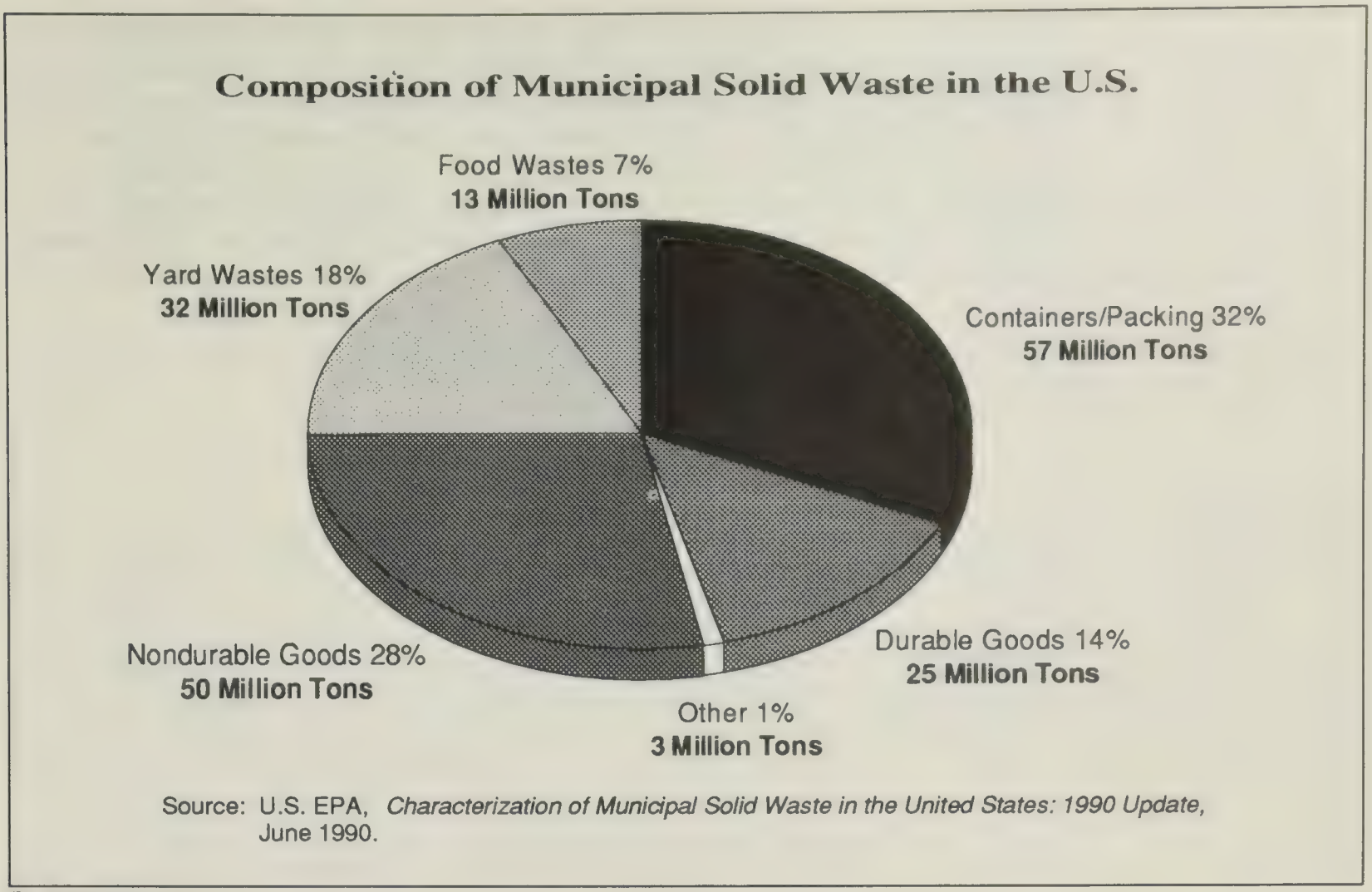

Composition of Municipal Solid Waste in the U.S.
Food Wastes 7%
13 Million Tons
Yard Wastes 18%
32 Million Tons
Containers/Packing 32%
57 Million Tons
Nondurable Goods 28%
50 Million Tons
Durable Goods 14%
25 Million Tons
Other 1%
3 Million Tons
Source: U.S. EPA, Characterization of Municipal Solid Waste in the United States: 1990 Update, June 1990.

Exhibit 6h.3

State and local governments within the United States continue to have the primary responsibility for municipal solid waste management. Such services are typically provided by local governments to their residents, with funding from general tax revenues. EPA has recently established stringent design and performance standards to ensure protection of human health and the environment that states and local communities will implement. EPA assists states and local governments by providing guidance and technical support as appropriate and encouraging states to complete solid waste management plans.

The goals of the federal government's municipal waste program, as stated in RCRA, are: 1) promoting environmentally sound disposal methods; 2) maximizing reuse of recoverable resources; and 3) promoting resource conservation. A 1989 EPA report entitled *Agenda for Action* described an integrated waste management approach and established a waste management hierarchy based on those goals. This hierarchy indicates that, although no single solid waste management technology is appropriate in all circumstances, certain waste management practices are generally preferred. Specifically, the hierarchy ranks the various waste management options in the following order of preference: 1) source reduction and reuse; 2) recycling, including composting; 3) incineration with energy recovery; and 4) use of landfills. Selection of a specific technology, however, is primarily the responsibility of the local community's solid waste program, consistent with statewide solid waste management plans.

The United States continues to make progress toward implementing its municipal waste management agenda. The federal government promulgated emission standards in January 1991 for municipal waste combustors and new technical standards for municipal waste landfills. These regulations are designed to control air emissions and ensure groundwater protection from municipal solid waste disposal facilities. Through actions

taken primarily by local governments, recycling of the nation's solid waste increased from nine to 13 percent from 1985 to 1988; this rate is expected to continue upward as the number of new recycling programs increases each year. For example, since 1988 the number of curbside recycling programs increased by approximately 170 percent to reach more than 2,700 programs nationwide. The city of Seattle, Washington, has a comprehensive solid and hazardous waste reduction program encompassing collection, public education, and technical and compliance assistance. Seattle recycles nearly 40 percent of its trash.

CASE STUDY

COMPREHENSIVE RECYCLING

Seattle, Washington

In 1988, after a thorough analysis of its waste stream and projected growth as well as the recycling market, Seattle set a goal to recycle 60 percent of its waste stream by 1998. The city embarked on a voluntary curbside program based on a variable rate, volume-based program. Customers "pay as they throw" so that the customer who uses a mini-can or 76-liter can for weekly pick-up pays $10.70 per month, while the customer who uses three cans (the national average) pays $31.75 per month. Recycling programs are free, and yard-waste collection service is offered at a very low price of $2 per month. Transfer stations are drop-off points for all recyclable materials plus cardboard, batteries, motor oil, mattresses, white goods (home and commercial appliances), lawn mowers, wood waste and tires. Seattle also has a permanent household hazardous waste drop-off site where rates are subsidized and soon to be free of charge.

By the end of 1991, Seattle will be recycling 40 percent of its commercial and residential waste stream. Eighty-five percent of the people in the city have voluntarily signed up for recycling and have put out an average of 28 kilos of material per month. Materials recycled include newspaper, mixed wastepaper, steel, aluminum, glass, and PET (polyethylene) plastic. Sixty-six percent of the citizens are using the curbside yard waste pick-up program which is already within three percent of meeting its 1998 goal. Seattle now has 97 percent of the residents on curbside garbage pick-up, with 89 percent using one can or less per week. Three-quarters of the city is served by one-person trucks making six to eight hundred stops per route per day.

With more than 16 different programs for customers to dispose of their waste, the Seattle customer is becoming extremely knowledgeable about environmental and waste-related issues and is capable of distinguishing types of materials that should go in particular waste programs. Furthermore, a combination of effective price signals and privatization has led to a cost-effective, economic system for the city.

During the summer of 1988, medical wastes washed up on the beaches of the east coast of the United States. This phenomenon created uncertainty about the adequacy of medical waste management practices in the United States, and caused great public outcry. In response, Congress amended RCRA to require a medical waste report and the development of a two-year demonstration program to track medical waste from generation to disposal in selected states. After reviewing the results of this demonstration program, Congress will consider the merits of national medical waste regulation.

Issues in Municipal Solid Waste

To build upon its progress, the United States continues to search for more innovative means of encouraging responsible municipal waste management. Among several options being studied are potential applications of economic incentives to reduce the amount of trash generated as well as to further encourage recycling. One such economic approach is variable rate pricing in which the price charged for waste services varies with the weight or volume that each household produces—similar to gas and electricity pricing. Several federal and state agencies are also participating in the development of life-cycle analysis, a method of evaluating the environmental effects of wastes from raw-material extraction through manufacturing to disposal. Also under investigation are tailored management programs for wastes that present special handling or management problems, for example, scrap tires and used oil.

One of the major issues currently being debated in both the courts and Congress is the degree to which states may place restrictions on the import of solid nonhazardous and hazardous wastes from other states. Some states believe that they have become the disposal ground for a disproportionate amount of the nation's waste. Other states are concerned that if their disposal options are limited by state import restrictions, the amount of waste requiring in-state disposal may outstrip available and environmentally sound waste disposal options. Congress is currently considering legislation to resolve this issue.

Underground Storage Tanks

Responding to an increasing threat to groundwater, in the 1984 amendments to RCRA, Congress required the federal government to regulate underground tanks, which store a range of substances from petroleum to other hazardous substances. There are approximately 2 million underground storage tanks (USTs) at approximately 750,000 facilities, predominantly at commercial gasoline stations, which are regulated by the federal government under the authority of RCRA.[20] An additional 3.1 million small USTs were exempted from regulation in the 1984 legislation; of these unregulated USTs, 2.7 million contain heating oil for homes and businesses; in addition, 440,000 farm and residential gasoline and heating oil USTs are not covered by the law.

Analysis done by the federal government in 1988 indicated that 15 to 20 percent of tanks are leaking or have the potential to leak over the course of their useful lifetime.[21] Consequently, some 300,000 existing underground tanks may be expected to require some type of remedial or corrective action. The regulations establishing the federal government's underground storage program went into effect in 1988. These regulations set technical standards for registration of existing USTs; design and installation of new USTs; a 10-year phase-in schedule for upgrading or replacement of all USTs and piping; and leak detection and prevention as well as corrective action. In addition to the technical standards, financial responsibility requirements were also established by law in 1986 as a part of the Superfund Amendments and Reauthorization Act. Most owners/operators of USTs are required to demonstrate through various means (i.e., letter of credit, self-insurance, pollution liability insurance) that they can pay for up to a $ 1 million cleanup, if one is required.

To deal with the problem of leaking USTs, the United States has adopted a two-pronged strategy: development of technical standards to prevent leaks from occurring in the future, and establishment of a Leaking Underground Storage Tank (LUST) trust fund. This $500 million fund is

generated from a gasoline tax and is used most often for investigations and corrective or remedial actions at abandoned UST sites or where the facility is bankrupt or when a responsible tank owner cannot be found.

Because of the overwhelming number and variety of underground storage tanks to be regulated, it was not considered practical to run a centralized federal UST program. The federal government, via the EPA, developed the technical standards, made training and technical assistance available to the states, delivered money directly to states for the UST programs, and has provided technical support. Under this innovative "franchise approach," as of the second quarter of fiscal year 1991 the following UST-related activities have taken place:[22]

Confirmed releases:	108,821
Cleanups initiated:	65,216
Releases under control:	48,147
Cleanups completed:	21,278
Trust Fund cleanups initiated:	431
UST closures:	259,654

Underground Storage Tank Issues

Despite significant progress made by the UST program to date, there are still numerous problems to be solved. Before the regulations went into effect, small, rural and other marginally profitable gasoline stations were having a difficult time competing with the major corporations that owned and operated tanks; many of the former were going out of business. Because it can cost a typical three-tank gasoline station up to $60,000 to comply with the UST program's technical standards, this trend has accelerated.

In addition, these same marginally profitable gasoline stations are having a very difficult time meeting the program's financial assurance requirements. Where pollution liability insurance has been available, it has been very expensive; in many places it has not been available at any price. Most insurance companies will not write such policies until a tank storage site has been upgraded to meet the new technical standards and the owner can demonstrate that any past leaks have been addressed. It is common for leaks to be discovered when USTs are being upgraded; as a consequence small owner/operators are having difficulties getting financing from banks to upgrade their tanks because the liabilities are uncertain. These problems have forced the federal government to delay the date for demonstrating financial responsibility for certain types of facilities, including small gasoline stations and independent fuel marketers. However, 43 states have established assurance funds to help bank owners meet these requirements. In those states, reasonably priced coverage is available to most small businesses with tanks.

The greatest challenge facing the national UST program and its state counterparts today are related to the growing number of sites where releases have been found. The federal government is working actively with state and local governments that are implementing the program to find faster, cheaper and more effective ways to perform and oversee cleanups. By streamlining their administrative processes and encouraging the use of newer, more effective cleanup technologies, UST programs can improve protection of the environment and minimize the serious economic impacts of UST releases.

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2. Council on Environmental Quality, *Environmental Quality: The Sixth Annual Report of the Council on Environmental Quality* (Washington, D.C.: U.S. Government Printing Office, 1975), pp. 363-400.
3. U.S. Environmental Protection Agency, *1987 National Biennial RCRA Hazardous Waste Report* (July 8, 1991).
4. U.S. Environmental Protection Agency, *RCRA Data Summary* (Washington, D.C.: 1990).
5. National Governors' Association, State Policy Reports, *Funding Environmental Programs: An Examination of Alternatives* (Washington, D.C.: Natural Resources Policy Studies, 1989).
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8. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, *The Nation's Hazardous Waste Management Program at a Crossroads. The RCRA Implementation Study* (Washington, D.C.: 1990).
9. See section 3017 of RCRA, as amended by HSWA, and its implementing regulations.
10. U.S. Environmental Protection Agency, National Enforcement Investigations Center Database, *Hazardous Waste Export by Receiving Country* (June 10, 1991).
11. Massachusetts was the first state to establish such legislation, passing its Toxic Use Reduction Act in 1989. This law was the first in the United States to require firms to develop pollution prevention plans. A dozen other states now have laws that require pollution prevention planning, and most states have some form of pollution prevention legislation. New Jersey recently enacted the Pollution Prevention Act of 1991, which shifts the focus of regulators from controlling the amount of pollutants released to limiting the production of these materials during the manufacturing process. It authorizes creation of a pilot program to test an innovative "facility-wide" permitting scheme whereby an individual factory can obtain a single permit and is rewarded for reducing hazardous materials use or production.
12. U.S. Environmental Protection Agency, *An Analysis of State Superfund Programs; Fifty State Study* (Washington, D.C.: 1989).
13. See *Community Relations in Superfund: A Handbook*; Interim Version, EPA/540/G-88/002, OSWER Directive 9230.0-3b (June 1988).
14. *Superfund Technical Assistance Grants*, EPA Publication No. 9230.1-05/FS (January 1990).
15. On July 27, 1990, the federal government proposed a rule which defines the process and cleanup goals for the corrective action program; see the *Federal Register*, vol. 55, p. 30798.
16. U.S. Environmental Protection Agency, *Evaluation of Groundwater Extraction Remedies*, EPA/540/2-89/054 (September 1989).
17. This mandate can be fulfilled in a variety of ways, including destruction, detoxification or immobilization of contaminants through the application of treatment technologies, or by controlling exposure to contaminants through engineering controls (such as containment), and/or through institutional controls that prevent access or ban certain uses of contaminated areas. Generally, the program requires the use of treatment for high concentrations of waste ("hot spots") and containment for lower concentrations of hazardous materials. Institutional controls are used primarily to supplement remedies and are usually not used in isolation.
18. U.S. Environmental Protection Agency, *Superfund 90 Day Study* (1989), pp. 1-3.

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20. U.S. Environmental Protection Agency, *Annual Survey of Underground Storage Tanks* (July 1990).

21. *Federal Register*, vol. 53, no. 185 (September 23, 1988): pp. 37086-37095.

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Biotechnology

Overview

Biotechnology is the use of various biological processes to make products and perform services from living organisms or their components. Biotechnology dates back thousands of years—to the time when human beings first began using microorganisms to produce bread, yogurt, wine and beer, and to modify plants and animals through selective reproduction for desired traits. The new biotechnology revolution began in the 1970s and 1980s, when scientists learned to alter more directly and precisely the genetic constitution of living organisms through techniques sometimes referred to as genetic engineering.[1]

It is now possible to modify plants, animals and microorganisms to carry specific desired genetic traits using much more precise and powerful techniques than traditional breeding. These new methods include the ability to identify, select and transfer specific genes from the cells of one organism to another; they also offer options for producing novel genetic combinations that would be extremely difficult or even impossible to obtain by classical methods.[2]

Biotechnology offers the promise of breakthroughs in the fields of human and veterinary medicine, foods, agricultural products, energy and environmental management. Applications may lead to healthier food products including meats, dairy products, fruits and vegetables; may greatly reduce reliance on toxic pesticides; and should improve the efficiency of plant responses to pesticides, fertilizers and irrigation.[3] Biotechnology could enable better use of renewable resources in a number of manufacturing processes and could facilitate sustainable agriculture practices, including integrated pest management. The technology thus offers the potential for increases in both productivity and efficiency. Possible increases in productivity might reduce the amount of land used for growing crops, grazing and timber activities, which in turn may help keep the loss of habitat in check.

The new biotechnology allows much more precise knowledge for predicting a modified organism's traits, reducing the probability of unexpected outcomes. Thousands of laboratory and field experiments have been conducted using organisms derived through the new biotechnologies. Although a small degree of scientific uncertainty will always remain regarding the prospective impact of any organisms on particular ecological processes, no accidents or problems with untoward effects on human health or the environment have yet occurred.

The United States continues to lead the world in the commercial development of most emerging biotechnology products. New techniques have spawned a diverse industry that now comprises more than 550 start-up firms, about 200 established firms that have diversified into biotechnology, and more than 400 supply firms in the United States alone. Some 15 years after its beginnings, the new biotechnology industry in the United States is producing pharmaceuticals, diagnostic tests and agricultural products worth over $2 thousand-million annually. (See Exhibit 6i.1.)[4]

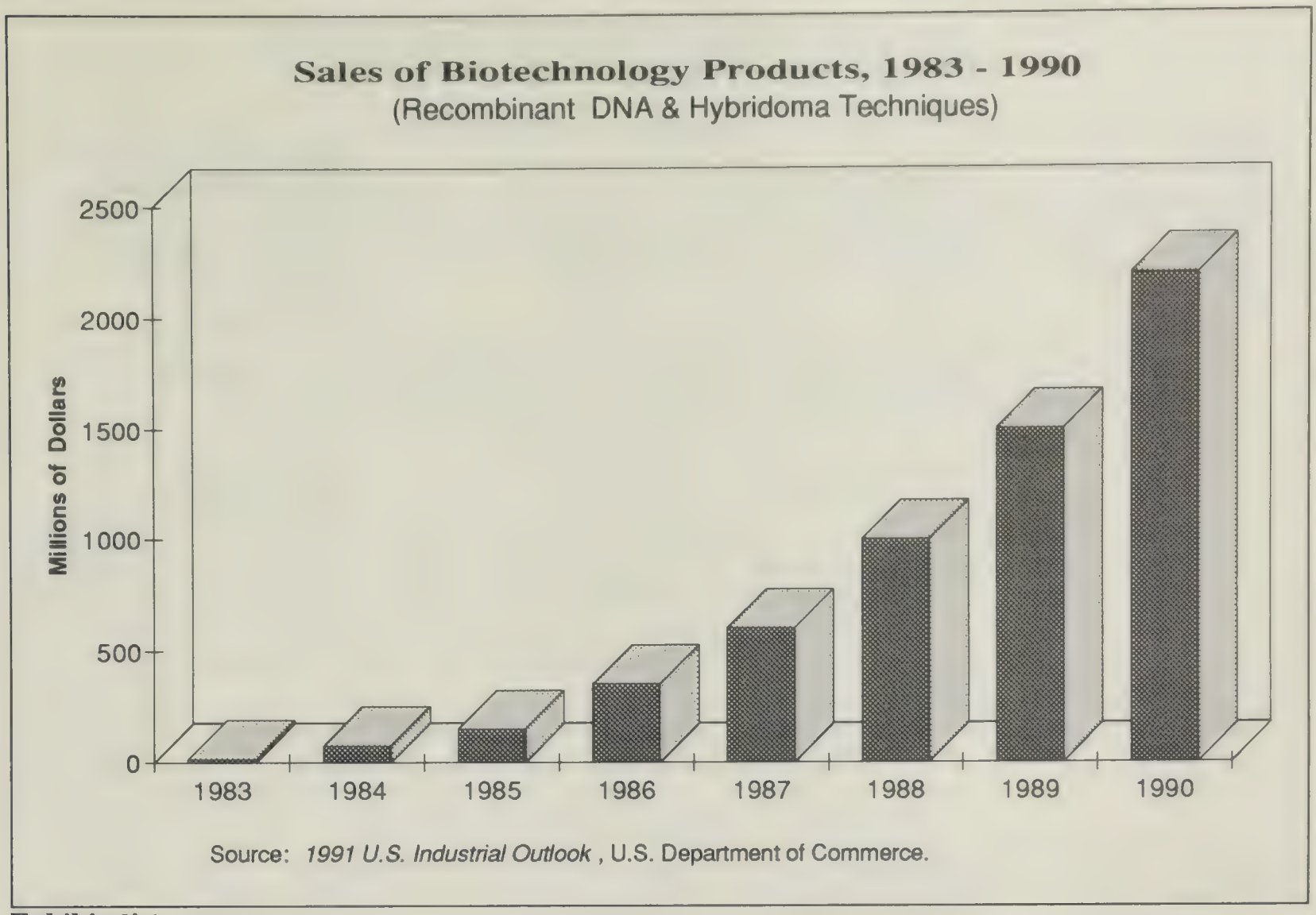

Exhibit 6i.1

Legal and Institutional Framework

In the United States, a federal interagency working group established a coordinated framework for oversight of biotechnology that addresses product safety, purity and efficacy, commensurate with risk.[5] Existing regulatory statutes provide a network of federal agency jurisdiction over both research and products. This legal structure is intended to safeguard human health and the environment while not discouraging desirable innovation. In addition, there are federal laws that provide protection of intellectual property rights to encourage research and innovation.

Within the legal framework governing biotechnology products, the level of federal oversight depends on the risk that a particular product or class of products presents under the proposed conditions of use. Because biotechnology is a collection of techniques that can be applied in many industries and sectors of the economy, it is not amenable to a single regulatory law or agency. Instead, like other methods and techniques that cut across industries, biotechnology regulation is achieved through the use of existing regulatory structures that govern the safety of research and products. (See Exhibit 6i.2.) The Food and Drug Administration (FDA) oversees foods, including animal feed, and regulates human drugs and veterinary pharmaceuticals; the U.S. Department of Agriculture (USDA) regulates veterinary biologics, meat and poultry products, and administers laws to protect agriculture from the introduction and spread of plant pests and animal diseases, including controls over the importation of plants and animals; the Environmental Protection Agency (EPA) regulates microbial pesticides and

THE FEDERAL BIOTECHNOLOGY FRAMEWORK

Lead Agency	Statutes/Guidelines		Organisms Jurisdiction Currently Regulated
USDA (Department of Agriculture)	Federal Plant Pest Act	Plant pests	Plants, invertebrate animals and microorganisms
	Virus-Serum-Toxin Act	Animal biologics	Microorganisms
	The Federal Meat Inspection Act	Meat & Meat Products	Certain animals slaughtered for food
	Poultry Products Inspection Act	Poultry & Poultry Products	Poultry
EPA (Environmental Protection Agency)	Federal Insecticide Fungicide, and Rodenticide Act	Pesticides	Microorganisms
	Toxic Substances Control Act	Chemical substances	Microorganisms
FDA (Food and Drug Administration)	Food, Drug and Cosmetic Act	Foods, drugs biologics	Plants, animals and microorganisms
NIH (National Institutes of Health)	Guidelines for Research Involving Recombinant DNA Molecules	Organisms produced by certain modern techniques	Plants, animals and microorganisms

Source: National Wildlife Federation. National Biotechnology Policy Center. *Biotechnology and the Environment.* Washington, D.C.: 1988: p. 39.

Exhibit 6i.2

other commercial microbial products. These may include certain microorganisms used for waste degradation, chemical production and conversion of biomass for alternative energy resources.

Federal Agency Oversight

Federal oversight of biotechnology products spans three areas: (1) certain research activities; (2) pre-marketing review and clearance of products; and (3) regulation of products in commerce, including import and export controls. The U.S. government provides oversight through such mechanisms as guidelines for product use; product information requirements; review by biosafety committees (local scientific review boards); mandatory licenses or permits; and import and export controls. For example, if a microorganism is proposed for use as a pesticide, careful review is conducted on the risks and benefits prior to registration (license for use), as is required for all pesticides in the United States. Field tests of certain plants and microorganisms may require federal permission. Since the mid-1980s, federal agencies have approved more than

290 field tests. Failure to comply with regulations for product approval may result in legal sanctions. The type of sanction imposed depends on the nature of the violation.

Federal agencies encourage public participation in product approval processes, including those for biotechnology products. Participation is made possible through requirements for public notice of proposed product licensing, opportunity for comment (with public hearings in specific instances), and public availability of documents, subject to protection of confidential business information.

Reduction of barriers to international trade in biotechnology products is also a goal of the U.S. framework. Accordingly, U.S. agencies apply the same risk-based oversight to domestic and imported products alike, and seek appropriate international harmonization of standards for products in commerce.

Principles of Regulatory Review

The President's Council on Competitiveness adopted four principles of regulatory review in August 1990 to be applied to the development of biotechnology products. The goal of these principles is to ensure that regulations and guidelines affecting biotechnology are based on current knowledge of potential risks according to the best-available science. The principles avoid excessive and inappropriate restrictions that curtail the benefits of biotechnology to society, while ensuring protection of health and the environment. The four principles are:[6]

- *Federal government regulatory oversight should focus on the characteristics and risks of the biotechnology product—not on the process by which it is created.* Products developed through biotechnology do not inherently pose risks to human health and the environment; risk depends instead on the characteristics and use of individual products. Biotechnology products shown to pose little or no risk should not be subject to unnecessary regulatory review during testing and commercialization. This distinction allows agencies to concentrate resources in areas that may pose substantial risks and leaves relatively unfettered the development of biotechnology products that present little or no risk.

- *For biotechnology products that require regulatory review, the process should be designed to minimize regulatory burden while assuring protection of public health and welfare.* Expedited review procedures should be adopted for products shown to be likely to pose lesser risk. The jurisdiction of the several regulatory agencies should be coordinated to avoid unnecessary confusion and delay, and agencies should use the same standards and apply them consistently. This is especially important where a product could be regulated by several agencies.

- *Regulatory programs should be designed to accommodate the rapid advances in biotechnology. Performance-based standards are, therefore, generally preferred over design standards.* A performance standard sets the ends or goals to be achieved, rather than specifying the means to achieve it (e.g., through a design standard). This provides companies and researchers with flexibility in choosing the best means of compliance. A performance-based standard for containment, for example, would permit alternative biological approaches for assuring containment, whereas a design-based standard might require specific physical barriers.

- *To create opportunities for the application of innovative new biotechnology products, all regulation in environmental and health areas—whether or not they address biotechnology—should use performance standards rather than specifying rigid controls or specific designs for compliance.* "Design-based" requirements may preclude use of biotechnology products even when such approaches may be both less costly and more effective. For example, a requirement to employ specific pollution control equipment would prevent use of innovative biotechnology pollution remediation or control techniques.

Endnotes:

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4. U.S. Department of Commerce, *U.S. Industrial Outlook* (Washington, D.C.: 1991).
5. Office of Science and Technology Policy, *Federal Register*, "Coordinated Framework for Regulation of Biotechnology; Announcement of Policy and Notice for Public Comment," (June 26, 1986), pp. 23302-23350.
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CHAPTER

7

ENVIRONMENTAL EMERGENCIES

Overview

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Technological Hazards

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Natural Hazards

■

Communications Systems

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International Efforts

OVERVIEW

The United States has made great progress over the past 20 years in preventing, preparing for and responding to emergencies caused by technological and natural hazards. Building on a history of voluntary response, the United States has developed a broad network of community, industry, state and federal programs to address issues of prevention, preparedness and response.

Environmental emergencies usually involve a release of hazardous materials such as oil, radiation or toxic substances. The degree of risk depends upon such factors as the nature and properties of the materials released, the environmental sensitivity of the affected area, the density of the population, and natural phenomena such as winds and climate. Natural hazards include wild fires, floods, hurricanes, earthquakes, volcanoes and other events of hydrologic, atmospheric or geologic origins. The degree of risk associated with natural hazards depends on the severity of the event, its proximity to industrialized and/or densely populated areas, and the level of prevention preparedness and response measures in place.

A hazardous release is considered "cleaned up" if threats have been mitigated or further actions are unnecessary. Stabilization occurs when immediate environmental threats to public health and welfare or the environment have been eliminated, but further actions to abate and mitigate longer-term threats may be required. In general, the technical complexity of responses has increased during the last decade because of stricter governmental regulations, advances in understanding health and ecological impacts, improved detection of contaminants, and developments in technical response capabilities. Great emphasis has been placed on federal coordination with state and local governments, and recent legislation furthers this strategy.

The distinction between hazards with technological and natural origins may be much less clear in reality than in theory. Some events, like wildfires, may have either human or natural causes (e.g., arson or lightning). Sometimes an emergency caused by human activity is made much worse by natural factors, such as winds or other climatic conditions. The reverse is also true: the effects of natural emergencies may be much more severe because of human decisions and behavior. Homes built on floodplains are an obvious example.

Actions may be taken in response to illegal dumping, transportation accidents or the release of hazardous materials at operating facilities or hazardous waste sites. Typical responses include sampling to determine type, location and level of contamination; fencing; drum removal and disposal; lagoon and pond control; and soil and debris excavation and disposal.

Other programs feature either research or application and foster transfer of technology. They are administered by about 20 different federal agencies with cooperation from all sectors of the public. One example is the Geographic Information Systems (GIS), a computer hardware and software system designed to collect, manage, analyze and display spatially referenced data. Such a system enables scientists to perform their traditional roles of data collection, research and information delivery more effectively. The U.S. Geological Survey (USGS) has installed GIS hardware and software at 40 offices that are linked across the United States.

Over the past few decades, U.S. prevention, preparedness, mitigation and response systems for environmental emergencies have continued to improve and change in the face of new experience. For example, in 1967, a spill of over 100,000 tons of oil by the tanker *Torrey Canyon* off the southwestern coast of England made the United States question its ability to respond to such spills if they occurred here. As a result, in 1968, several federal agencies developed the National Multiagency Oil and Hazardous

Materials Contingency Plan. This eventually became known as the National Oil and Hazardous Substance Contingency Plan or simply the National Contingency Plan.

When provisions for emergencies were first included in legislation during the 1970s, they were almost all response-oriented. For example, the Federal Water Pollution Control Act (1972) provided response authority in the event of a release of oil and/or hazardous wastes into the nation's water supply. In 1974 Congress enacted the Federal Disaster Relief Act which established a mechanism for providing federal assistance in mitigation, response and recovery activities related to natural disasters.[1] Then, in December 1981, President Ronald Reagan directed a series of executive branch activities designed to improve the nation's ability to respond to peacetime domestic disasters as well as national security emergencies. These activities resulted in a National Policy Statement (1982), and a National Plan of Action (1983) that have guided further executive branch actions and programs.

During the past decade, the United States has shifted its emphasis towards preparedness. In 1986, a new law addressed emergencies at the local level by allowing the public to become more involved. The Emergency Planning and Community Right-to-Know Act not only requires local communities to plan for chemical accidents, but it also strengthens their role in the preparedness process. The law assures local communities access to information, and ensures their active participation in preventing, preparing for and responding to toxic chemical releases from industrial facilities in their midst.

These initiatives, coupled with the evaluation of existing plans, have led to the recent development of the Federal Response Plan. A key feature of the Federal Response Plan is its inclusion of 12 Emergency Support Functions (ESFs):

ESF #1 — Transportation
ESF #2 — Communications
ESF #3 — Public Works and Engineering
ESF #4 — Firefighting
ESF #5 — Information and Planning
ESF #6 — Mass Care
ESF #7 — Resource Support
ESF #8 — Health and Medical Services
ESF #9 — Urban Search and Rescue
ESF #10 — Hazardous Materials
ESF #11 — Food
ESF #12 — Energy

These ESFs may be activated on an individual basis or collectively in response to the specific requirements of a disaster or emergency. Similarly, each ESF may be partially or fully activated, depending on the unique characteristics and needs of the situation.

Over the years, efforts to prevent emergencies have become a logical extension of preparedness and response programs. The economic costs of effective prevention often are a fraction of response costs, and prevention can avoid severe human and environmental costs. The Clean Air Act Amendments of 1990, which recognize and build on the broad-based nature of existing chemical accident prevention activities, establish an important legislative basis for accident prevention in the 1990s. The act requires that additional information be provided to communities on the way businesses manage technological risks and encourages facilities to improve their safety practices by preparing risk management plans. Effective accident prevention requires close cooperation among federal, state and local government, the public and industry.

TECHNOLOGICAL HAZARDS

Every day, oil and other hazardous substances are spilled or released into harbors and waterways, onto the ground and into the air. The Federal Water Pollution Control Act (FWPCA), which was enacted in 1972, established the National Response Center to provide a common point of contact for reporting all pollution incidents and notifying federal authorities responsible for formulating a response. There has been steady growth in the number of releases reported since 1978, and in 1990 the National Response Center received over 16,000 reports of releases of oil and hazardous substances.[2] Also in 1990 a national report examining the risk posed by an accidental release of toxics indicated that over 2,000 accidental releases of toxicants occur annually.[3] Only 2.4 percent of the total incidents resulted in 90 percent of the total chemicals released, and most of these came from fixed facilities and occurred on land. In the United States, chlorine, ammonia, sulfuric acid, hydrogen chloride and sulfur dioxide—all large volume industrial chemicals—are the chemicals that most frequently result in evacuation, injury or death. Among the types of incidents reported are oil spills, derailed tank cars or overturned trucks leaking toxic gases, and fires and explosions that release hazardous substances. Some of these incidents are relatively minor, while other incidents cause death and other types of serious damage. For example, a May 1988 refinery explosion in Norco, Louisiana, killed seven people, injured 50 more and forced the evacuation of 25,000 nearby residents. Such incidents are tragic reminders of our continued vulnerability to technological hazards and highlight the need to focus on accident prevention.

National Response System. Under the authority of the Federal Water Pollution Control Act and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the United States has established the National Contingency Plan (NCP). The NCP is designed to provide the organizational structure and procedures for government response actions, to ensure a coordinated response to oil spills and releases of hazardous substances, and to provide federal expertise to these emergency situations. It addresses preparedness and response, as well as notification and communication with the public. In most cases the party accountable for an incident is responsible for managing whatever cleanup is necessary. In cases where the responsible party is unknown or incapable, the federal government works with state or local governments to provide an appropriate response. Federal response authority may be used to clean up or stabilize a site in cases where state or local response capabilities are inadequate to address the emergency.

The National Contingency Plan also establishes a National Response System with national, regional and local components. The National Response Team is responsible for coordinating federal planning, preparedness and response actions. It is made up of 15 federal agencies, each having broad environmental responsibilities. Also integral to the National Response System is a strong system of Regional Response Teams, which include representatives of the same federal agencies, as well as state participants. The Regional Response Teams are responsible for developing and maintaining Regional Contingency Plans for their respective areas. During an accident response, the purpose of the National and Regional Response teams is to support those managing the cleanup. At all other times, the purpose is to assure that an effective and functional infrastructure for preparedness, response and mitigation is in place at all levels of government—federal, state and local. The federal, state and local responders are the backbone of the system, and great emphasis is placed on coordination with state and local governments.

Management of the federal response to an emergency is overseen by an on-scene coordinator. The U.S. Environmental Protection Agency (EPA) deploys more than 100 on-the-scene coordinators in its 10 regional offices to handle spills or releases to inland zones; the U.S. Coast Guard has responsibility for the coastal zone areas, adjacent shorelines, designated inland river ports and harbors, and the Great Lakes. In most cases, the on-scene coordinator monitors the responsible party to ensure a proper and timely cleanup or to provide technical support to state or local government responders. The National Response Center serves as the central communications center and notifies coordinators when accidents are reported.

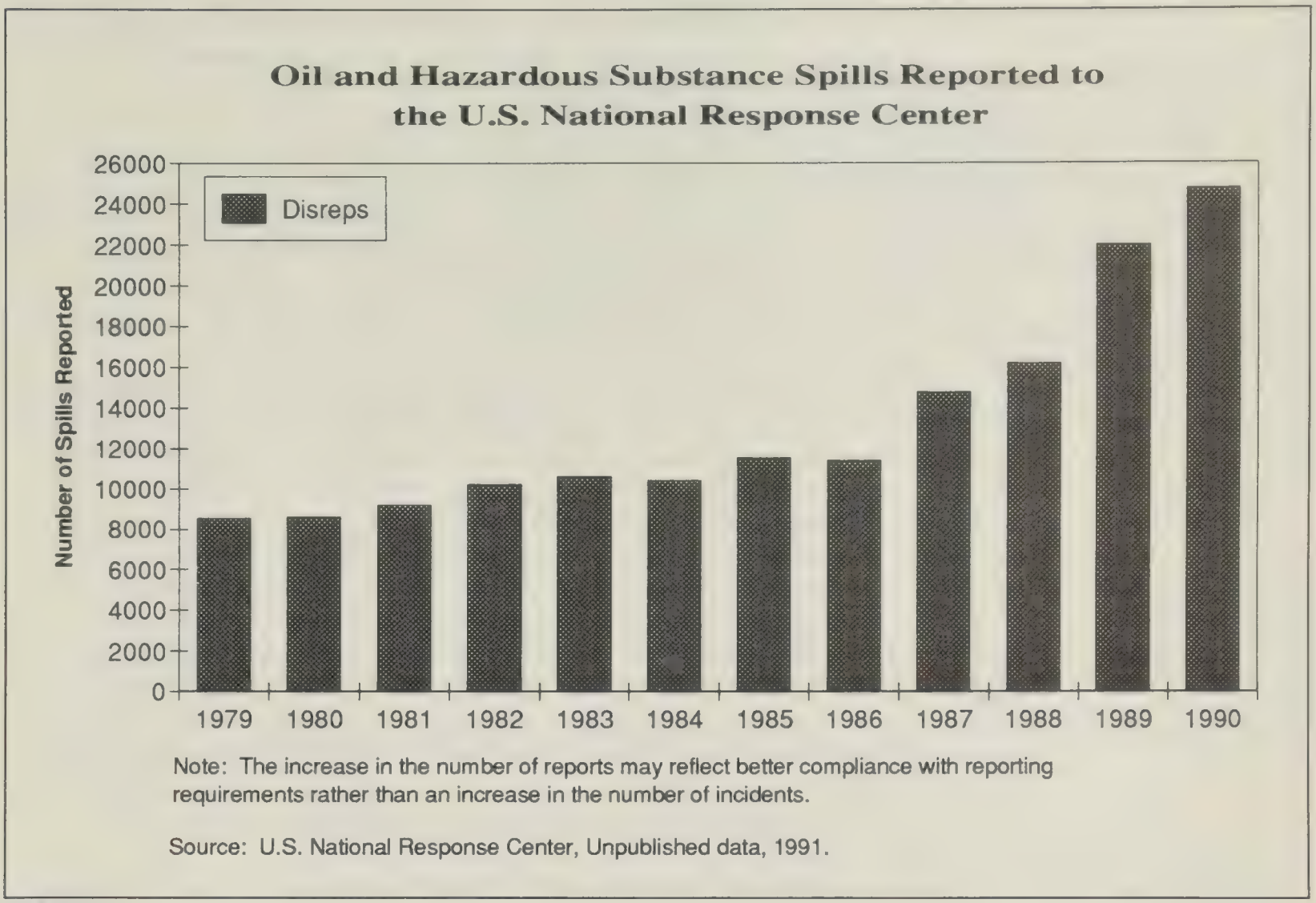

Exhibit 7.1

Right-to-Know

In December 1984, a cloud of highly toxic methylisocyanide (MIC) spewed from a chemical plant in Bhopal, India, blanketing the surrounding area. More than 2,000 people died and thousands more were injured. This tragedy opened the eyes of the world to the dangers of chemical accidents. Eight months later, a less toxic derivative of that same chemical escaped from a sister plant in Institute, West Virginia, underscoring the immediacy of these concerns to the United States.

The U.S. Congress determined that, in contrast with most other countries, which operate on a "need to know" basis for governmental and other authorities only, in the United States the general public also has a right-to-know about the presence and use of hazardous chemicals in their communities. Accordingly, in the 1986 Superfund Amendments and Reauthorization Act (SARA) Congress passed the Emergency Planning and Community Right-to-Know Act (EPCRA)—Title III of SARA. In addition, in Section 126 of Title I, Congress also addressed the risk of injury to employees

by providing that the U.S. Department of Labor issue worker protection regulations that would provide no less protection for workers engaged in hazardous waste operations and emergency response operations.

EPCRA has brought emergency planning for chemical accidents directly to the local level through the formation of state and local entities with emergency planning and community right-to-know responsibilities. State Emergency Response Commissions are responsible for appointing, supervising and coordinating activities of the Local Emergency Planning Committees. All 50 states, five U.S. territories, and the District of Columbia have established commissions. Approximately 3,900 local committees have been formed. Nearly half the states now have laws to complement and to implement EPCRA; 17 have established fee systems to support state and local programs.

The law requires that local committees include representatives from a wide variety of groups including elected state and local officials; law enforcement, civil defense, firefighting, first aid, health, environmental, hospital and transportation personnel; media; community groups; and facility owners and operators. Literally hundreds of thousands of facilities must provide information to the Local Emergency Planning Committees. Both state commissions and local committees establish procedures for collecting and responding to public requests for information. Local committees are responsible for preparing, updating and exercising local emergency response plans.

The system, however, is not perfect. It is estimated that almost 50 percent of all facilities have failed to comply with the reporting requirements. Funding and other support for state commissions and local committees vary across the country and in general are viewed as lower priorities than other state and local responsibilities. Similarly, the capabilities of the Local Emergency Planning Committees vary; many have not yet completed and tested their emergency plans and some are not active or functioning at all. Consequently, Congress passed the Hazardous Materials Transportation Uniform Safety Act (HMTUSA) in 1990 to address local preparedness and response in the event of a hazardous substance release. HMTUSA not only built on the existing planning system by naming State and Local Emergency Planning Commissions and Committees, but it provided long-awaited funding to these groups for preparedness activities and training. The act makes available $5 million in annual grants to states for training of emergency responders.

Concurrent with governmental efforts, there are also many private initiatives underway to help prevent, prepare for and respond to emergencies. For example, the Chemical Manufacturers Association has designed a program called Community Awareness and Emergency Response. The program provides guidance and advice to industry concerning local community involvement and interaction in emergency prevention and planning. The association has also recently developed a Responsible Care program, which is an initiative designed to foster the chemical industry's continued improvement in health, safety and environmental management, and to do so in response to public concerns.

Overall, EPCRA has led private-sector interest and community groups to work closely with local governments in planning and preparing for technological emergencies, and thus to minimize damage to human health, property, environmental systems and ecology. These concepts of broad-based planning, public right-to-know and industry involvement to prevent environmental emergencies continued to appear in the legislation which followed.

Many additional federal programs contribute to the effectiveness of the National Contingency Plan. One further example is the Hazardous Materials

Response Program (HAZMAT) administered by the National Oceanic and Atmospheric Administration (NOAA). HAZMAT involves developing scientific plans and coordinating scientific information related to spills occurring in coastal waters, the Exclusive Economic Zone and the Great Lakes. The program provides assistance through satellite observations, definition of problems, and advice on minimizing the impact and cleanup of hazardous waste sites.

CASE STUDY

FERTILIZER PLANT EXPLOSION

Ouachita Parish, Louisiana

The Ouachita Parish, Louisiana Local Emergency Planning Committee has paid considerable attention to the risk of chemical releases and has been quite active in the Emergency Planning and Community Right-to-Know process. Starting with an existing, well-developed all-hazards contingency plan, and relying on the intensive orientation and training of all its members, the committee was able to move quickly towards accomplishing its assigned mandate: development of a hazardous chemical contingency plan.

On May 1, 1991, the local IMC fertilizer plant exploded and burned. Within 15 minutes of that explosion, the Local Emergency Planning Committee obtained Emergency Planning and Community Right-to-Know information on the hazardous chemicals present at the facility and made it available to police and firefighters responding to the incident. Consequently, the emergency responders at the scene had essential information about hazardous chemicals at the facility at the time they struggled to put out the fire. In addition, the Louisiana State Emergency Response Commission provided this same data to federal authorities within 45 minutes of the explosion. Availability of information and rapid coordination were critical factors in making appropriate response decisions under emergency conditions at the site.

Prevention. Effective strategies for preventing accidents require cooperation from and involvement with the public, industry and labor, as well as government regulation. The United States initiated a non-regulatory prevention program in the mid-1980s, along with other laws, to complement response and emergency planning programs already mandated by the Comprehensive Environmental Response, Compensation and Liability Act. While CERCLA focused primarily on legal liability as an incentive to prevent releases of hazardous substances, the new prevention program identifies additional incentives for preventing technological accidents. This program is based on the premise that, while industry bears the primary responsibility for preventing and mitigating chemical accidents, environmental groups, professional organizations, public interest groups and government at all levels can help facilities that use dangerous chemicals to identify hazards and find safer ways to operate. Much of the new program involves the collection of information on accidental releases and industry safety practices. It has yielded valuable insights into the causes of many accidents and how to improve chemical process safety. Many such safety measures have made businesses more efficient and productive.

The Clean Air Act Amendments of 1990 also complement the voluntary prevention program by adding new legal requirements. The amendments require fixed facilities with threshold quantities of designated

substances to develop detailed plans for managing the risks associated with their operations. It also institutes new measures for detecting, monitoring and preventing accidental releases of chemicals. The law requires the investigation of accidents in order to provide information that will help prevent future releases. Again, the federal government provides regulations and guidance, while container facilities themselves maintain the primary responsibility for ensuring safe operations.

Three U.S. states—New Jersey, California and Delaware—have already adopted legislation that requires facilities using dangerous chemicals to develop risk management plans to prevent accidental releases. The experience of these states is a valuable asset as the federal government develops national requirements for accident prevention. In future years, the U.S. anticipates that other states will initiate prevention programs as well.

Oil Pollution. The Oil Pollution Act of 1990 creates a comprehensive prevention, response, liability and compensation regime to address spills from vessels and fixed facilities. The new law substantially increases federal oversight of oil transportation by setting new requirements for vessel construction (including double-hull requirements for certain vessels), crew licensing and staffing. It mandates vessel and facility contingency planning, enhances federal response capability, broadens enforcement authority, increases penalties, and creates a new research and development program. Area committees will be formed across the country to develop contingency plans for major spills as part of the National Response System. Up to $1 thousand-million per spill is available from a trust fund authorized by the act to cover cleanup costs and damages not compensated by the spiller, whose financial responsibility requirements are significantly increased. Additionally, the petroleum industry has created and funded a multimillion-dollar new organization to address catastrophic marine oil spills.

Transportation. The United States has developed special regulations to address spill-related issues in the transportation of crude oil. Requirements under the Hazardous Materials Transportation Act (1975) have been established to prevent transportation incidents from taking place and to mitigate their effects should they occur. These regulations set up requirements for placarding hazardous cargos and packaging shipments of hazardous materials, as well as safety standards for shipping containers. The Hazardous Materials Transportation Uniform Safety Act of 1990 (HMTUSA) increased financial assistance for state and local emergency planning and training and other transportation safety measures.

In addition, the Chemical Manufacturers Association operates the Chemical Transportation Emergency Center (CHEMTREC) to provide 24-hour industry advice and assistance to chemical shippers, handlers and those responding to chemical emergencies. During such emergencies, CHEMTREC can provide information regarding the effects of most chemicals on persons or the environment and suggest methods for treatment, containment and control of an incident.

Radiological Emergencies. Prevention and preparedness planning for radiological emergencies from commercial nuclear power plants are part of the licensing process for power plants regulated by the U.S. Nuclear Regulatory Commission. The U.S. Federal Emergency Management Agency (FEMA) regulates off-site emergency preparedness for nuclear facilities. Following a meltdown at the Three-Mile Island nuclear power plant in Pennsylvania in 1979, an Executive Order required FEMA to establish the Federal Radiological Emergency Response Plan, which sets forth U.S. policy for

CASE STUDY

THE *EXXON VALDEZ*

Prince William Sound, Alaska

Shortly after midnight on March 24, 1989, the 296-meter tank vessel *Exxon Valdez* struck Bligh Reef in Prince William Sound, Alaska. Government and industry plans, individually and collectively, proved to be initially insufficient to control an oil spill of the magnitude of the *Exxon Valdez* incident. The very large spill size, the remote location and the character of the oil all tested spill preparedness and response capabilities.

Many lessons learned from the *Exxon Valdez* incident must be addressed if the U.S.'s ability to plan for and respond to major oil spills is to improve. First and foremost is that prevention is the first line of defense. Avoiding accidents remains the best way to assure the quality and health of our environment. Complacency is a major enemy. The infrequency of major spills in the 1980s contributed to the complacency that ultimately exacerbated the effect of the *Exxon Valdez* spill. However, some accidents are inevitable; thus, better planning and preparedness, and enhanced response capabilities are essential to reduce environmental risk. In particular, both public and private research is needed to improve cleanup technologies—mechanical, chemical and biological. The successful use of bioremediation techniques in cleaning the oiled Alaskan beaches has significant implications for future oil spill cleanups. Studies of long-term environmental and health effects must be undertaken expeditiously and carefully to ensure safety for affected residents of the spill area and full restoration of the affected resources. The Oil Pollution Act of 1990 in large measure addresses these concerns.

responding to any accident at a nuclear facility, an accident involving nuclear weapons or a transportation accident involving hazardous materials.[4] Three-Mile Island was an accident involving a slow release due to malfunction of the cooling system. This leak was soon brought under control. Three-Mile Island is no longer a cause of great concern. In contrast, the meltdown at Chernobyl in the former Soviet Union involved a very large release of hazardous material. By underscoring the seriousness of radiological emergencies and the need for preparedness, the Chernobyl incident affected U.S. activities and will for many decades. The role of U.S. state governments in planning for such emergencies within their boundaries varies from state to state, however. Safety in the design, maintenance and operation of nuclear power plants continues to be a major public concern.

Over the past 20 years the United States has developed a comprehensive planning, preparedness and response structure for technological accidents at the federal, state, local and facility levels. The Clean Air Act Amendments, HMTUSA and the Oil Pollution Act have moved the United States further into the area of accident prevention. Much remains to be done, however, in strengthening all components of the system and in fully developing accident prevention capabilities.

NATURAL HAZARDS

Communities throughout the United States are at risk from one or more natural hazards. Natural emergencies may strike at frequencies ranging from several times each year (e.g., floods, landslides, tornadoes, hurricanes, wildfires and volcanic eruptions) to once every few years (e.g., damaging earthquakes, tsunamis and drought), to once a century or longer (e.g., major earthquakes in Alaska, California and the Mississippi Valley area, explosive volcanic eruptions in Hawaii, the Pacific Northwest and Alaska). Following is a brief review of natural hazards in the United States:

- *Flooding.* All states are at risk from flooding, which causes average annual losses of $4 thousand-million and affects community development, agriculture and water quality.

- *Landslides.* Landslides, which cause average annual losses of $2 thousand-million, occur in all of the states and insular areas.

- *Hurricanes and Tornadoes.* Hurricanes and tornadoes cause average annual losses of $2 thousand-million. They can flatten national forests and damage utility systems, affecting water quality. Hurricanes strike the Gulf and Atlantic Coasts virtually every year. Tornadoes frequently hit the interior of the nation along "tornado alley" in Oklahoma, Texas, Kansas and adjacent states and the insular areas.

- *Volcanoes.* Parts of Alaska, Hawaii, Washington, Oregon, California, Arizona, Wyoming and New Mexico are at risk from volcanic eruptions, which may destroy timber land, affect air and water quality, disrupt air traffic and cause serious property damage.

- *Wildfires.* Wildfires occur every year across the nation and can damage natural resources and threaten communities.

- *Tidal Waves.* In the past 150 years, tsunamis—large oceanic waves generated by a submarine earthquake or volcanic eruption—have struck Hawaii, California, Alaska, Washington, Oregon, Puerto Rico and the Virgin Islands.

- *Drought.* Drought is episodic, striking all regions of the nation from time to time, causing severe water shortages and significantly affecting water quality.

- *Earthquakes.* Although earthquakes, which cause average annual losses of $1 thousand-million per year, occur most frequently in Alaska (e.g., 1964 Prince William Sound) and California (e.g., 1906 San Francisco and 1989 Loma Prieta), all parts of the nation are vulnerable. A single earthquake has the potential for killing, injuring and displacing thousands and can cause in excess of $50 thousand-million in direct economic losses. Earthquakes can trigger landslides, rupture pipelines and cause fires.

Preparedness, Mitigation and Response to Natural Hazards

A number of comprehensive federal programs have been created to reduce loss of life and societal impacts from natural hazards. They feature either research or applications and foster transfer of technology. They are administered by about 20 different federal agencies or departments in cooperation with all sectors of the public. Primary responsibility for providing financial and technical assistance to state and local government to prepare

CASE STUDY

THE LOMA PRIETA EARTHQUAKE

Loma Prieta, California

At the height of rush hour, at 5:04 P.M. Pacific Daylight Time, on October 17, 1989, a major earthquake struck northern California. Its epicenter was about 12.8 kilometers northeast of Santa Cruz, at a small hill called Loma Prieta. The Loma Prieta Earthquake, as it became known, disrupted the World Series of Baseball and was the largest to hit a major population center in the United States since the 1906 California earthquake.

Many secondary consequences such as fires and releases of toxic chemicals were avoided due to preparedness and response programs and the high level of awareness of earthquake risk in the region. As a result, the death toll was minimal. There is no question of the particular effectiveness regulations designed for earthquake resistance, including seismic design requirements and improved building codes. Most of the buildings that did collapse were not reinforced and acted as predicted. Roads' and bridges' seismic design was a requirement. A case in point is the section of the Interstate 880 bridge which collapsed, killing 41 of the total 62 people who died as a result of the earthquake.

The ability of responders to extricate people from collapsed structures was an additional success during the earthquake. Local fire and police officers and the state of California were responsible for expedient rescue efforts and generally effective fire control. Technological advances allowed officials in Washington, D.C. and California to be immediately and constantly in contact to affect the response. All of these factors contributed greatly to the success of the response to the Loma Prieta Earthquake. They point to significant advances in the prevention of loss of human life and mitigation of suffering and destruction as a result of planning and preparedness.

for, respond to and recover from natural disasters rests with the U.S. Federal Emergency Management Agency.

In carrying out its mandate, FEMA cooperates with many other federal disaster reduction agencies (e.g., the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency and the Department of Health and Human Services), as well as voluntary non-profit agencies such as the American Red Cross. FEMA also cooperates in technology transfer with U.S. scientific agencies (e.g., the National Science Foundation, the U.S. Geological Survey and the National Oceanic and Atmospheric Administration (NOAA)), which sponsor or conduct national research programs to enhance understanding of the physical and biological nature of natural hazards, improve engineering and management of environmental systems, and advance the social sciences needed for understanding human behavior and reducing losses.

Another major national preparedness program is the National Oceanic and Atmospheric Administration's National Weather Service watch and warning program. In addition to daily weather forecasts, the National Weather Service provides timely notice of impending natural hazards to ensure protection of life and property. These activities occur through national weather centers. For example, NOAA's National Hurricane Center in Miami, Florida, the Pacific hurricane office in Honolulu, Hawaii, the National Severe Storms Forecast Center in Kansas City, Missouri, and 13 River Forecast Centers are on year-round alert for dangerous storms. Tsunami warning

centers are found in Hawaii and Alaska to warn of the approach of these deadly earthquake-generated ocean waves.

Weather observations are collected from hundreds of locations. The data collection centers include surface and upper-air observing stations, weather radar sites, ocean buoys, weather reporting ships, environmental satellites and voluntary observers. These data are shared with national weather services worldwide.

Overall, federal disaster relief efforts are coordinated, and the Disaster Assistance Program activated, when the President of the United States declares a disaster in accordance with the Stafford Act.[5] The program provides federal response assistance to state and local authorities, and individual and public assistance to residents and communities struck by a disaster or emergency. The goal is to facilitate the recovery effort and to provide emergency assistance.

Fortunately, when the government falls short of responding to an emergency, the activities of volunteers in response to disasters are significant. Volunteer efforts in response to disasters like Hurricane Hugo in 1989 were largely responsible for the recovery of damaged areas and for the health and well-being of affected populations. Volunteer actions during the response to the Loma Prieta Earthquake are directly responsible for rescues from collapsed buildings and bridges. Cadres of volunteers are credited with providing food and shelter to the many people who were homeless as a result of the earthquake. The financial contributions from the American people after such disasters have been extraordinary.

Volunteer efforts are not insignificant. In fact, the American Red Cross, with a network of approximately 2,700 local chapters, responds to over 55,000 disaster incidents annually and provides an average of $50,000,000 a year in relief for disaster victims.

As with technological hazards, experience with natural hazards has demonstrated that the number of natural disasters and the severity of their impacts can be reduced sharply if communities adopt and enforce preparedness and mitigation measures rather than taking actions solely in response to a disaster. Current practice in the United States is moving away from reaction to anticipation because much more is now known about such critical factors as: the recurrence, frequency, and intensity of natural hazards; their physical and/or biological character; techniques for predicting their occurrence and consequences; and effective avoidance and mitigation strategies to alter, reduce or prevent the impacts.

Loss-reduction measures for natural hazards include preparation; prediction, warning and evacuation; emergency response; disaster recovery and reconstruction (restoration of community services and reconstruction to improved standards); and intervention/suppression (for some natural hazards such as wildfires).

COMMUNICATIONS SYSTEMS

Technology transfer nationally and internationally is central to the application of most U.S. emergency-related programs. The goal is to transfer scientific results and methodologies and apply them in loss-reduction measures at the federal, state and local levels of government and within the private sector. These results and methodologies are also shared internationally.

Emergency management and response requires the best information available. During the past 20 years computers and the new

information systems have significantly improved our ability to plan and respond to accidents and natural disasters. Computers that used to occupy large rooms and demand a special, controlled environment are now the size of briefcases and are able to withstand broad temperature and humidity ranges. This means that planners and responders can carry computers to the field where they are most useful. Operating system software has similarly improved, making these machines much easier to use.

Telecommunications improvements in satellite communications and portable/transportable radio hookups can now provide video, data and voice communications from field locations. Compact, fully integrated units can be deployed to the scene and tie in field operations with other sites and telecommunication networks.

New computer programs are able to integrate data and maps, making planning and response to accidents and natural disasters more effective. Responders can use Geographic Information Systems to quickly access geographical/map and text information concerning the location of high-risk facilities, special populations, evacuation routes and zones, and hydrological features. Planners can use GIS to conduct risk analyses, develop simulations and perform exercises.

Effective new programs in emergency response situations often require access to multiple sources of data. Differences on how the data are collected, documented and stored hinder these systems from delivering their full potential. Management of data lags far behind hardware and software development, and represents an area in need of continuing support.

INTERNATIONAL EFFORTS

The U.S. international emergencies program is designed to accelerate the transfer of technology in order to cope with technological and natural emergencies. Such emergencies increasingly are due to population growth, urbanization, and the concentration of industry and infrastructure in geographic areas prone to recurrent natural hazards.

For example, the U.S. Office of Foreign Disaster Assistance helps foreign countries in their disaster management. Pre- and post-disaster assistance have been provided in many instances such as floods in Bangladesh; volcanic eruptions in Columbia, Peru and the Philippines; earthquakes in the former Soviet Union, Mexico and the Philippines; a natural toxic pollution disaster in Cameroon; and a major hazardous waste site problem in Nigeria. In addition, through cooperative agreements, the United States provides weather data for global weather analyses and forecasting. The United States and other nations use this information to prepare for severe storms and to lessen their impact on lives and property. Orbiting and geostationary satellites generate much of this data. The United States is also planning a comprehensive, balanced and integrated program of research and applications on natural hazards during the 1990s as part of the United Nation's International Decade for Natural Disaster Reduction (IDNDR). The IDNDR is a multinational program created to reduce loss of life and impacts on the environment and development. The basic premise of the U.S. program is that, although natural hazards will inevitably continue to occur, their effects can be significantly mitigated.

The United States has also played an important role in establishing some international preparedness and prevention programs. For example, at the 1989 Conference on Security and Cooperation in Europe (CSCE) in Sofia, Bulgaria, the United States greatly contributed to the development of a chemical accident policy. The United States also actively contributed to the

development of the United Nations Economic Commission of Europe (ECE) conventions implementing the CSCE policy. Finally, the United States has recently begun a series of projects to assist Eastern European countries with planning for chemical accidents.

The United States also continues to strengthen its relationships with Canada and Mexico in emergency preparedness and response in transboundary regions for the mutual benefit of all three countries. In addition to developing joint response plans along the length of their frontiers, the United States and Mexico have initiated development of local joint response plans in 28 paired "sister cities" along the border.

As a result of accidents like the one in Bhopal, India in December 1984, there is also an increasing recognition of the need for international cooperation within multinational institutions to prevent, prepare for and respond to emergencies. In response to this need, the Organization for Economic Cooperation and Development (OECD) has developed a comprehensive set of guiding principles for accident prevention, preparedness and response programs for both developed and developing nations. The United Nations Environment Program (UNEP) is assisting developing countries in emergency preparedness and accident prevention through the Awareness and Preparedness for Emergencies at Local Level (APELL) program. The U.N. International Program on Chemical Safety has been developing International Chemical Safety Cards on many hazardous substances for use by countries for emergency preparedness and response. And, in 1990, the International Maritime Organization completed an agreement on responding to oil spills at sea. These initiatives offer great promise for increasing the capability to withstand technological and natural hazards, and to minimize the number and severity of technological and natural emergencies worldwide.

Endnotes:

1. Public Law 93-289.
2. Parties responsible for releasing hazardous substances (e.g. facilities, transporters) are required to notify the National Response Center if the release exceeds specified quantities. For oil spills, any discharge resulting in a sheen on the water is required to be reported.
3. The report was from the Science Advisory Board's Relative Risk Reduction Strategies Committee to the administrator of the U.S. Environmental Protection Agency, William K. Reilly.
4. The Federal Radiological Emergency Response Plan was approved in 1985 and revised in 1991.
5. Public Law 93-288, as amended.

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CHAPTER

8

ENVIRONMENTAL IMPACT ASSESSMENT

Overview

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Purpose of the EIA Process Under NEPA

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Agency Responsibilities

■

Judicial Review

■

Current Issues

OVERVIEW

Throughout the United States in the 1960s, public interest and involvement in environmental protection grew rapidly and gained substantial political momentum. Individuals and organizations concerned about the environment called for legislation that would require federal government agencies to give greater consideration to the environmental consequences of proposed projects and programs. In response, the U.S. Congress passed the National Environmental Policy Act of 1969 (NEPA), the first federal environmental law in the United States to apply broadly to the activities of the federal agencies themselves. NEPA marked "an effort for the first time to impress and implant on the federal agencies an awareness and concern for the total environmental impact of their actions and proposed programs."[1] It represents this nation's widest effort to address environmental problems on a preventive and anticipatory basis.

In enacting NEPA, Congress established a national policy of using "all practicable means and measures...to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic and other requirements of present and future generations of Americans."[2] In addition to providing the basic national charter for environmental protection and enhancement within the United States, the language of NEPA also calls upon the federal agencies to "[r]ecognize the worldwide and long-range character of environmental problems and, where consistent with the foreign policy of the United States, lend appropriate support to initiatives, resolutions, and programs designed to maximize international cooperation in anticipating and preventing a decline in the quality of mankind's world environment."[3]

To carry out this new environmental charter, Congress directed the agencies of the federal government, as an integral part of their planning and decision-making, to ensure that environmental amenities and values are given appropriate consideration by preparing "detailed statements" on the environmental impacts of all proposals for legislation and other "major federal actions significantly affecting the quality of the human environment."[4] These "detailed statements" have come to be called environmental impact statements (EISs), and the process underlying the preparation of those statements by federal agencies has come to be called the NEPA or environmental impact assessment (EIA) process.

NEPA, also created the Council on Environmental Quality (CEQ) to oversee the implementation of its own provisions, to provide environmental advice to the President and to prepare an annual Environmental Quality report that would review government activities affecting the environment, and present and discuss national environmental conditions and trends. To assist the federal government in complying with the objectives of NEPA, CEQ has issued regulations that tell the agencies how to implement the procedural EIA requirements of the law.[5]

PURPOSE OF THE EIA PROCESS UNDER NEPA

To achieve the purposes of NEPA as stated above, the EIA process has two principal objectives: (1) integrating environmental considerations into the federal agency decision-making process, and (2) encouraging participation by other federal agencies with specialized expertise and by the public in the preparation of the EIS and, through that process, in the eventual decision. The CEQ regulations implementing NEPA set forth various procedures to

achieve these two objectives, and require that the EIS documents be published and made available for agency and public comment. However, as the regulations themselves state, NEPA's purpose is not to generate paperwork—even excellent paperwork—but to foster excellent action. The NEPA process is intended to help public officials make decisions that are based on an understanding of environmental consequences and take actions that protect, restore and enhance the environment.[6]

Integration of Environmental Values

If environmental considerations are to be integrated effectively into agency decision-making, the assessment of potential environmental impacts must begin early in an agency's planning process, "to insure that planning and decisions reflect environmental values, to avoid delays later in the process, and to head off potential conflicts."[7] The CEQ regulations provide that agencies should begin the preparation of environmental documents "as close as possible to the time the agency is developing or is presented with a proposal so that preparation can be completed in time for the final statement to be included in any recommendation or report on the proposal."[8]

NEPA documents must not be produced for the purpose of justifying decisions already made. Rather, the agency must explore and evaluate all reasonable alternatives to a proposed action, and present a comparison of the environmental consequences of these alternatives. This analysis of alternatives is the "heart of the environmental impact statement" and, if done correctly, should sharply define the issues and provide a clear basis for choice by the decision-maker and the public from several feasible options.[9]

Two levels of reporting on the environmental effects of a proposed action have evolved under NEPA. The first of these is an environmental assessment (EA); this is a concise public document that provides a brief analysis of environmental consequences, including a discussion of alternatives.[10] An environmental assessment is often undertaken to determine whether or not the second level of analysis, preparation of an environmental impact statement (EIS), is needed. If the analysis shows that the environmental impacts of the proposed action will not be significant, then the EA serves as the basis for a Finding of No Significant Impact (FONSI). If the EA analysis indicates that significant impacts are likely, or if such a determination is made by the responsible agency at the outset of the planning process, then the agency proceeds to prepare an EIS. Actions in classes that the agencies have determined in advance will not have individual or cumulative significant effects on the environment are given a "categorical exclusion" from these documentation requirements.[11]

If an EIS is prepared, the responsible agency must demonstrate that it has adequately considered environmental values by preparing a Record Of Decision (ROD) at the conclusion of the EIA process. The ROD must state what the decision is, identify all alternatives considered by the agency in reaching its decision, specify the alternative that was considered to be environmentally preferable, state whether all practicable means to avoid or minimize environmental harm from the selected alternative have been included, and summarize any applicable monitoring, enforcement and mitigation commitments.[12]

Public Involvement

The second important purpose of the EIA process is to promote public participation. Again, the regulations implementing NEPA include several procedures to facilitate public involvement in the preparation of an EIS.

First, an agency must publish a notice of intent to prepare an EIS. This notice must describe the proposed action and possible alternatives, and must outline the agency's plans for preparing the EIS.[13]

Second, the agency must develop "an early and open process for determining the scope of the issues to be addressed and for identifying the significant issues related to a proposed action."[14] As part of this "scoping" process, the federal agency must invite the participation of affected agencies, American Indian tribes, and other interested persons and organizations (including those who may be opposed to the action on environmental grounds); determine the scope of the issues and alternatives to be considered in the EIS; and indicate the relationship between the timing of the preparation of environmental analyses and the agency's tentative planning and decision-making schedule. Further, as part of the scoping process, the agency may set page limits and time limits, and hold a public scoping meeting.

Environmental impact statements are prepared in two stages: draft and final. Both stages must ordinarily be completed before the responsible agency may reach a final decision and proceed with the planned action. Draft EISs must be made available for comment by other government agencies and the public for a minimum of 45 days. Comments on a draft EIS may address either the adequacy of the statement, or the merits of the proposed action and alternatives discussed, or both.[15]

The agency responsible for the EIS must review the comments it receives on the draft EIS and include its responses to all substantive comments in the final EIS. Such responses have included modifying the proposed alternatives, evaluating alternatives not previously considered, supplementing or improving its analyses, making factual corrections and explaining why a comment does not warrant further agency response.[16] Once the agency considers and responds to these formal comments, it then issues the final EIS and circulates it to those who provided comments. After a minimum 30-day waiting period following the issuance of the final EIS, the agency may then issue its ROD and implement its decision.

AGENCY RESPONSIBILITIES

NEPA requires agencies of the federal government to "[u]tilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decision-making...."[17] To meet this responsibility, an agency must select the staff who will prepare a particular EIS, and must make sure that its areas of expertise are appropriate to the issues identified in the scoping process. A list of the preparers is to be included in the EIS.

Lead Agency Responsibilities

NEPA and the regulations give primary responsibility for NEPA compliance to the federal agency proposing the action. Under NEPA, "action" refers not only to undertaking a direct federal agency project or program, but also to issuing a permit or license sought by a private applicant or non-federal entity. Acting as the "lead agency," the proponent agency must supervise the preparation of the EIS, and is ultimately responsible for the scope and content of the EIS prepared.[18]

In addition, at the request of a lead agency, other federal agencies with jurisdiction by law or special expertise may become "cooperating agencies." Cooperating agencies are expected to participate in the scoping process, assume responsibility for developing information and preparing environmental analyses for the EIS at the request of the lead agency, and make available staff and other support to enhance the lead agency's interdisciplinary capability.[19]

CASE STUDY

DEVELOPMENT AND SITING OF TRAINING FACILITIES

Fort Polk, Louisiana

One important objective of the National Environmental Policy Act (NEPA) is to assure that the natural environment is maintained in a status which combines aesthetic values with productive human uses. This environmental management objective has become widely accepted in the United States and is given a high priority—even when it competes with critical needs such as national security. In order to meet that objective, priorities and choices among alternatives in environmental manipulation must be planned and managed at all levels of government decision-making, as is illustrated by the U.S. Army's experience in the development and siting of new training facilities at Fort Polk, Louisiana.

The Army's decision in the early 1980s to equip the Fifth Mechanized Infantry Division at Fort Polk with the newest combat vehicles—the Abrams main battle tank, the Bradley fighting vehicle and the Apache attack helicopter—also created a need for substantially upgraded training facilities at the fort, including modern vehicle and weapons test ranges. Planning for those facilities, however, did not focus exclusively on training mission needs or criteria; instead, as required by NEPA, environmental considerations were integrated fully into the overall planning process for development and siting of the training facilities. As a consequence, in the very early stages of site evaluation, planners were alerted to the fact that the area under study also provided nesting habitat for the red-cockaded woodpecker, an endangered species.

The threat to the woodpecker population, together with other concerns for effects on the quality of the environment, prompted the Army to invoke the environmental impact statement (EIS) process, NEPA's most comprehensive procedure, which requires agencies to take a "hard look" in public view at the effects of their proposed activities and document the results. Public "scoping," conducted as part of that process for the purpose of identifying and assigning priorities to study issues, revealed yet another potentially serious impact—increased noise levels from vehicle and weapons testing could disrupt the community.

Significant environmental issues, including the impacts on endangered species and noise levels in the community, were identified in the NEPA process and then examined in the context of four alternative training sites within the boundaries of the fort. After issuing a draft EIS, on which comments were invited, and a final EIS, which took into consideration all comments submitted, the fort's commander selected the training site from among the alternatives considered. The selected site was not the "best" for the purpose of meeting criteria for upgrading training mission facilities alone, or for avoiding adverse environmental impacts; rather, combined with measures to mitigate some environmental harm and ensure the protection of endangered species, the site was deemed "satisfactory" on both counts.

The environmental process that was undertaken for development and siting of Fort Polk's new training facility meets NEPA's goal of responsible environmental management by reaching a constructive compromise and preserving future options in an open, forthright and cooperative process. The Fort Polk experience also demonstrates that national security interests—certainly one of the country's top priorities that countenances neither waste nor delay—can effectively and efficiently be served without sacrificing important environmental quality objectives, as long as environmental considerations are built into the mission and facility planning processes of federal agencies.

Role of CEQ

CEQ oversees federal agency implementation of the NEPA process. In addition to promulgating and interpreting its general regulations to implement the environmental impact assessment process, CEQ works with the federal agencies on specific projects to insure full compliance with NEPA.

CEQ also has responsibility for resolving interagency environmental disputes. If, after reviewing a lead agency's EIS, another federal agency believes that a proposed action is environmentally unsatisfactory, the matter can be formally referred to CEQ by the head of the concerned agency.[20]

The CEQ regulations establish procedures for such pre-decision referrals. If, after reviewing the documentation required for such a referral, CEQ determines that the issue raised is "of national importance because of the threat to national environmental resources or policies," it may take one of several actions, including obtaining additional views and information, publishing the CEQ's own findings and recommendations, and submitting its recommendations to the President for action.[21]

Role of the Environmental Protection Agency

The U.S. Environmental Protection Agency (EPA) receives and files all draft and final EISs prepared by federal agencies; EPA also reviews and comments on all EISs. Using a standard rating system, EPA's comments address both the adequacy of the analysis and the significance of the potential environmental impacts. These comments are available to the public. EPA also has the authority to refer to CEQ federal legislation, federal projects or proposed federal regulations which it believes to be "unsatisfactory from the standpoint of public health or welfare or environmental quality...."[22]

Role of the States

The National Environmental Policy Act recognizes that the participation of state and local governments is essential to achieve the goal of a high quality environment for all citizens, and the act encourages cooperation among all levels of government.[23] While NEPA was intended primarily to shape federal decision-making, its sponsors were confident that "state, local and private action [would] also be favorably influenced." The sponsors of NEPA also believed that it would "provide a model and a demonstration to which state governments may look in their efforts to reorganize local institutions and to establish local policies conducive to sound environmental management." The value of NEPA as a model for state governments grew out of the belief that "many of the most serious environmental problems... [were] within the scope and, often, within exclusive jurisdiction of state action and state responsibility."[24]

As expected, a number of states implemented a system of environmental impact assessment, modeled after NEPA, in the early and mid-1970s. Frequently referred to as "little NEPAs," these laws vary a great deal in respect to their legal basis, administration and requirements. Nineteen states, the District of Columbia and Puerto Rico have enacted "little NEPAs" by statute or executive order.[25] Some states, such as California, New York and Washington, have established vigorous environmental impact assessment (EIA) systems, supported by comprehensive regulations and active judicial enforcement.[26] Other states have systems that apply to a narrower range of activities and that appear to be less dynamic in their relationship to state decision-making.[27]

Recently, there appears to be a resurgence of interest in state "little NEPAs." In 1986, the Montana Environmental Quality Council held a conference focusing on Montana's EIA process. In November 1987, CEQ co-sponsored with the Environmental Law Section of the New York State Bar Association a conference focusing on the preparation and review of environmental impact statements at both the state and federal levels. The state of Washington undertook a major revision of its state Environmental Protection Act in 1988, and in 1989 the Council of the District of Columbia passed its first "little NEPA" law.

Also in 1989 the governor of New Jersey revised the state's executive order governing the New Jersey environmental impact assessment process. The states of Michigan and Maine are considering the establishment of state agencies, similar to CEQ, that will be responsible for the state environmental impact assessment processes.

Municipalities also have adopted "little NEPA" procedures. For example, New York City established an EIA procedure by executive order in 1977 as part of its responsibilities under New York's Environmental Quality Act.[28]

CASE STUDY

EXPANDING WASTEWATER TREATMENT FACILITIES

Everett, Washington

In 1982 Everett, Washington, a city on the Pacific northwest coast of the United States, began to develop alternatives for expanding its wastewater treatment facilities on Smith Island in the lower Snohomish River Basin. The city's preferred alternative consisted of expanding the existing diked lagoon system into a wetland and disposing of sludge on-site. The U.S. Environmental Protection Agency anticipated that the city would submit a construction grant request to the federal government under Title II of the Clean Water Act and a dredge and fill permit request under section 404 of that act. With this in mind, EPA Region X and the U.S. Army Corps of Engineers, Seattle District, required the city to reevaluate alternatives so that both agencies could begin preparation of NEPA compliance documents. The state of Washington's Department of Ecology also required further evaluation of alternatives pursuant to its own state Environmental Policy Act.

Three environmental issues were of principal concern: 1) the effects of inundating and diking 30 hectares of wetland located in a 100-year floodplain near a major river that supports anadromous fisheries; 2) the potential impact of sludge disposal within such an area; and 3) recurring violations of water discharge permit conditions at the existing plant. In addition, the project required coastal zone consistency approval. The EPA grant request and the Corps permit decision required extensive negotiations and consultation among several agencies: EPA, the Corps of Engineers, the city management agency, and state agencies such as the Department of Wildlife and Ecology. Throughout the process several public meetings were held, with extensive public input.

The consultation process resulted in substantial changes to the city's plan. A new treatment and disposal alternative was selected that would affect only about five hectares (including approximately three hectares of wetland) and would also allow for an improved operating system with higher capacity. The facility was redesigned to be in full compliance with federal flood insurance regulations, and the city selected a new method of sludge disposal—composting with subsequent land application on off-site silvicultural or agricultural areas.

The new plan had far less environmental impact; it met water-discharge permit conditions; and the public found it far more acceptable. Further, the adverse effects on the almost three-hectare wetland area were to be mitigated by reclamation and enhancement of another nearby 5.3-hectare disturbed wetland, which satisfied resource agency concerns.

The resolution of these issues allowed both EPA and the Corps of Engineers to complete environmental assessments and to determine that the final project would not result in significant impact to the human environment. The Corps of Engineers issued a 404 permit to the city in December 1987. Subsequently, EPA issued a Finding of No Significant Impact (FONSI); a construction grant was provided to the City of Everett in September 1988. When the project is completed, Everett, Washington, will have obtained a reliable treatment facility with higher capacity and fewer environmental impacts than were proposed in 1982, and at a lower cost to its citizens.

JUDICIAL REVIEW

The federal courts have played a major role in the interpretation and implementation of NEPA. Although NEPA itself establishes no separate cause of action under which an aggrieved person could challenge an agency action, the courts have allowed plaintiffs to challenge the procedural aspects and the substantive adequacy of EISs by alleging violations of the federal Administrative Procedure Act.[29]

From the beginning, the courts have insisted that the federal agencies comply with NEPA "to the fullest extent possible." This phrase, found in NEPA Section 102,

...does not provide an escape hatch for foot-dragging agencies; it does not make NEPA's procedural requirements somehow 'discretionary.' Congress did not intend the Act to be a paper tiger.[30]

The courts have also recognized that while NEPA does not require substantive results in particular problematic instances, the procedural provisions in the act are designed to see that all federal agencies do, in fact, exercise the discretion given them to meet the environmental protection goals of NEPA. "Other statutes may impose substantive environmental obligations on federal agencies, but NEPA merely prohibits uninformed—rather than unwise—agency action."[31]

The courts have stated that federal agencies must take a "hard look" at the environmental consequences of their actions and appropriately document their efforts.[32] In addition, the courts have found that NEPA was designed to insure a fully informed and well-considered decision, but not necessarily one the judges of the court would have reached if they had been members of the decision-making body.[33] The language of NEPA does not contemplate that a court should substitute its judgment for that of the agency with respect to the environmental consequences of its actions.[34]

In 1989, a total of 57 cases were filed that involved a NEPA cause of action. The number of NEPA cases filed annually has decreased steadily since 1980, and is now well below the peak of 189 cases that were filed in 1974.

CURRENT ISSUES

In the 21 years since NEPA was enacted, the federal agencies, in general, have become increasingly proficient in preparing procedurally adequate environmental impact statements. In the future, the challenge for the agencies will be to comply with the spirit of NEPA in "fulfill[ing] the responsibilities of each generation as trustee of the environment for succeeding generations...."[35] Among the issues CEQ is pursuing in this regard are (1) full integration of other environmental review requirements into the EIA process, and (2) consideration of transboundary and extraterritorial environmental impacts.

Integration of Environmental Review Requirements into the EIA Process

NEPA calls upon the federal agencies to integrate environmental concerns into their policy development and decision-making, and uses the EIA process as the mechanism to ensure this result. There has been a tendency, however, for agencies simply to treat NEPA as another paperwork requirement rather than to fully integrate environmental quality objectives into their decision-making. Many federal agencies are confronted with another dilemma: how to accommodate the environmental quality objectives contained in NEPA and many other federal, state and local environmental laws, while at the same

time carrying out the agency's primary mission—when that mission may be at odds with those objectives.

CEQ has recently completed a survey of how agencies are implementing the policy goals of NEPA in the context of alternatives examined in EISs and in the agencies' final decision about proposed actions.[36] The results of this survey confirm that two initiatives are needed: a renewed emphasis on effectively and efficiently using the EIA process as an integral part of the decision-making process, and a complementary effort to reduce the duplication and delay that often accompanies the environmental review process and highlighting excellent NEPA compliance. CEQ is considering guidance on how to ensure the introduction of pollution prevention and biological diversity concepts and objectives into the EIA process, as well as how to promote procedural integration through increased training and educational efforts. CEQ is also chairing an interagency task force to improve the integration of environmental factors into the process of siting energy facilities.

Transboundary, Extraterritorial and Global Environmental Impacts

The issue of how best to assess environmental impacts that occur in another country or in the global commons is currently a subject of much discussion in the United States. Concerns have been expressed about the possible application of NEPA to actions the United States undertakes in another country. These concerns focus primarily on legal issues and on how to obtain and consider the views of other governments.

In 1979, Executive Order 12114 was issued by the President to address the assessment of environmental effects abroad of major federal actions. Under this order, agencies must prepare environmental analyses for actions affecting the environment outside the territorial jurisdiction of any nation, such as the oceans and Antarctica, and for actions affecting the environment of a foreign nation which is not participating with the United States in the action.

Recently, the United States signed the Convention on Environmental Impact Assessment in a Transboundary Context, drafted and sponsored by the United Nations Economic Commission for Europe (ECE). The Convention establishes a system of notification, shared information and consultation among ECE member signatories.[37]

In addition, under the 1909 U.S.-Canada Boundary Waters Treaty, the two countries carry out water quality and water resource environmental assessments as needed through the International Joint Commission (IJC) established under the treaty. An IJC report issued in 1988 on the Flathead River Basin provides an excellent example of U.S.-Canadian cooperation in the assessment of potential impacts of development on the pristine Flathead River ecosystem and the Waterton-Glacier International Peace Park region. And, the United States is currently preparing a review of U.S.-Mexican environmental issues, including the possible effects of a North America Free Trade Agreement (NAFTA).

SUMMARY

Two decades after establishing the first national charter to make environmental protection and enhancement an integral part of government policy, the United States has gained a great deal of experience and made considerable progress in its efforts to fulfill the purposes set forth in its National Environmental Policy Act. The federal agencies, which must assess the environmental impacts of their proposed actions, have—for the most part—come to realize that compliance with NEPA results in better, more environmentally sound

and more publicly acceptable decisions. There is, however, a continuing challenge before the federal agencies to fully embrace the intent as well as the procedures of environmental impact assessment. There is also much work remaining for the Congress, the states and the citizens of the United States to undertake, before the goal of NEPA—to create and maintain conditions under which human beings and nature can exist in productive harmony—is fully achieved.

Endnotes:

1. *Congressional Record* vol. 115 no. 29 (1969): p. 59.
2. National Environmental Policy Act of 1969 (NEPA), section 101(a).
3. NEPA, section 102(2)(F).
4. NEPA, section 102(2)(C).
5. The NEPA regulations are contained in the Code of Federal Regulations (C.F.R.), Chapter 40, parts 1500 through 1508. The C.F.R. citations below are to the relevant subsections of the NEPA regulations.
6. 40 C.F.R. § 1500.1(c).
7. 40 C.F.R. § 1501.2.
8. 40 C.F.R. § 1502.5.
9. 40 C.F.R. § 1502.14.
10. 40 C.F.R. § 1508.9.
11. 40 C.F.R. § 1508.4.
12. 40 C.F.R. § 1505.2.
13. 40 C.F.R. § 1508.22.
14. 40 C.F.R. § 1501.7.
15. 40 C.F.R. § 1503.3(a).
16. 40 C.F.R. § 1503.4.
17. NEPA, section 102(2)(A).
18. 40 C.F.R. § 1501.5.
19. 40 C.F.R. § 1501.6.
20. 40 C.F.R. Part 1504.
21. 40 C.F.R. § 1504.3.
22. 42 U.S.C. § 7609(b).
23. 42 U.S.C. § 4331(a).
24. *Senate Report* No. 91-296, 91st Congress, 1st Session 6(1969).
25. Ark. Stat. Ann. sec. 8-1-101; Cal. Pub. Res. Code sec. 21000 et seq.; Conn. Gen/ Stat. Ann. sec. 22a-20; District of Columbia Environmental Policy Act of 1989; Bill 8-8; Fla. Stat. sec. 380.92 *et seq.*; Hawaii Rev. Stat. sec. 343-1-343-8; Ind. Code Ann. sec. 13-1-10-1-10-8; Md. Nat. Res. Code Ann. Sec. 1-301 to 305; Mass. Ann. Laws ch. 30, sec. 61-62H; Executive Order 1974-4 (Michigan); Minn. Stat. Ann. sec. 116D. 01 to 07; Mont. Code Ann. sec. 75-1-101 to 75-1-105; 75-1-202; Executive Order 215 (September 11, 1989) (New Jersey); N.Y. Environ. Conserv. Law sec. 8-0117; N.C. Gen. Stat. sec. 113-A-1 to 10; P.R. Laws Ann. tit. 12, sec. 1121-1127; S.D. Codified Laws Ann. sec. 34A-9 to 34A-9-12; Va. Code 10-17.107 to 10-17.112; State of Utah Executive Order (August 27, 1974); Wash. Rev. code sec. 43.21C010-21C.910; Wash. Admin. Code R. 197-11; Wis. Stat. sec. 1.11 and Wis. Admin. Code NR 150.01-40.

26. See, D.R. Mandelker, *NEPA Law and Litigation* (Deerfield, IL: Callaghan & Company, 1984, 1988 supp.), chapter 12. The author discusses the "little NEPA" laws of California, New York and Washington, and gives an overview of state laws of this type.
27. Virginia's law, for example, is triggered only by state projects costing $100,000 or more, except for road and highway projects.
28. New York City Executive Order No. 91, June 1977.
29. 5 U.S.C. § 702.
30. *Calvert Cliffs' Coordinating Committee v. Atomic Energy Commission*, 449 F.2d 1109 (D.C. Cir. 1971), cert. denied, 404 U.S. 942 (1972).
31. *Robertson v. Methow Valley Citizens Council*, U.S., 109 S.Ct. 1835 (1989).
32. *Kleppe v. Sierra Club*, 427 U.S. 390 (1976).
33. *Vermont Yankee Nuclear Power Corp. v. Natural Resources Defense Council*, 435 U.S. 519 (1978).
34. *Strycker's Bay Neighborhood Council v. Karlen*, 444 U.S. 223 (1980).
35. NEPA, section 101(B)(1).
36. Michelle Wiseman, "Consideration of Alternatives in the NEPA Process," To be published in *Environmental Professional* vol. 14 (1992).
37. U.N. Economic Commission on Europe, Convention on Environmental Impact Assessment in a Transboundary Context (Finland: February 25, 1991).

CHAPTER

9

ENVIRONMENTAL EDUCATION

Overview

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1990 National Environmental Education Act

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Government

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Schools

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Non-Governmental Organizations

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Industry

■

Communications Media

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Issues in Environmental Education

OVERVIEW

In the United States, the first Earth Day celebration, held April 22, 1970, is often credited with heightening the national environmental consciousness. On that day, more than 20 million Americans participated in well-publicized environmental programs, demonstrations and celebrations.

Since then, support for environmental programs in the United States has continued to grow, with ever-increasing public participation in all aspects of environmental decision-making. In a survey taken in 1990, more than three-quarters of the respondents believed that major efforts are needed to improve the environment.[1] In the last few years, American consumers have become more environmentally aware, improving their understanding of both environmental issues and how personal actions affect environmental quality.

Environmental education has been a part of the process aimed at solving environmental problems and preventing the development of new ones. This chapter provides a brief overview of the status of environmental education, including a condensed history and a look at current issues. Although support for environmental education has fluctuated in the past two decades, many view environmental education as fundamental to slowing environmental degradation and creating a sustainable global society.

Background

The roots of environmental education date back to the turn of the century. Wilbur Jackman's *Nature Study in the Common Schools* was published in 1891, and in 1896 Cornell University in New York state began promoting nature study through a series of leaflets which emphasized learning through discovery.

Beginning in the 1930s, classroom studies of conservation reflected growing concern about environmental problems and the need to wisely manage and conserve natural resources. National laws were passed during the following decades mandating that teachers develop and use conservation education programs. In the 1950s, emphasis shifted to outdoor education, providing urban youth in particular with opportunities to experience the natural environment.

By the late 1960s public awareness about the seriousness of environmental problems was growing. To deal with the complex environmental problems that faced the nation, educators and environmentally concerned citizens and organizations worked to create a new process of education—one that built on nature conservation and outdoor education, but added a special focus on the social and behavioral dimensions of environmental problems. This new approach, labeled "environmental education," focused on creating an environmentally literate citizenry.

In 1970, Congress passed the first National Environmental Education Act. Funded from 1971 to 1975 and managed by the Department of Health, Education and Welfare, the act paid for several important research and curriculum development projects. It was aimed exclusively at elementary and secondary schools, and called for creation of a national advisory council and sponsored a modest domestic grants program. But with a change of national priorities in the early 1980s, this federal program was discontinued.

In 1972, the United Nations Conference on the Human Environment recommended that organizations of the United Nations establish an international environmental education program. The United Nations Educational, Scientific and Cultural Organization (UNESCO) began activities that led to the 1977 intergovernmental conference on environmental education in Tbilisi in the former Soviet Union. The conference endorsed worldwide environmental education goals, guiding principles and target outcomes. The

Tbilisi conference called for "education directed towards the solution of practical environmental problems through an interdisciplinary approach and the active and responsible involvement of each individual and of the community".[2]

The goals adopted at Tbilisi included:

- Fostering clear awareness of, and concern about, economic, social, political and ecological interdependence in urban and rural areas;
- Providing every person with opportunities to acquire the knowledge, values, attitudes, commitments and skills needed to protect and improve the environment; and
- Creating new patterns of behavior of individuals, groups and society as a whole toward the environment.

In 1978, a National Leadership Conference on Environmental Education outlined an environmental education strategy for the United States which included the establishment of a center for environmental education planning and coordination at national and state levels to implement the Tbilisi recommendations. Although the strategy was not fully implemented, a Federal Interagency Committee on Education (FICE) Subcommittee on Environmental Education did provide a formal network of environmental education professionals working in various agencies. With that exception, environmental education evolved for the next decade with minimal support from the federal government.

From 1978 to 1988, environmental education received increasing attention at the state level and within the college and university community. Many non-profit organizations, nature centers, museums and other non-formal institutions assumed leading roles in environmental education and continued to support and fund initiatives ranging from teacher-training to curriculum development projects. With the passage of a new National Environmental Education Act, environmental education is again a key component of the national, state and local agenda to help create a sustainable global society.

Recently, new impetus has been given to education efforts at every level of society. In 1989, President George Bush and the state governors established national goals for improving education in the United States, and ensuring that students are prepared for responsible citizenship. One of those six goals calls for America to be first in the world in science and mathematics by the year 2000. The AMERICA 2000 strategy is a comprehensive plan to move every community in America toward the National Education Goals. Consequently, new environmental education initiatives may be enhanced by the increased national focus on math and science education.

1990 NATIONAL ENVIRONMENTAL EDUCATION ACT

In November 1990, environmental education gained momentum with the enactment of the second National Environmental Education Act which is far more expansive than the act passed in 1970. The 1990 act addresses the need for international cooperation; targets elementary, secondary and postsecondary students, and senior citizens; and seeks to foster collaboration between the federal government and the media, private industry, schools, museums, libraries, parks and recreation facilities. According to the act, "It is the priority of the United States to establish and support a program of education on the environment...through activities in

schools, institutions of higher learning and related educational activities, and to encourage postsecondary students to pursue careers related to the environment."[3]

An Office of Environmental Education has been established in the Environmental Protection Agency to help coordinate national and international environmental education activities. The office is working closely with many other governmental agencies, educational institutions, and non-profit organizations to manage an environmental education clearinghouse, identify and fill in existing gaps in environmental education activities, support the training of environmental educators and provide opportunities for environmental internships.

A National Environmental Education Advisory Council has been formed with members drawn from primary, secondary and college-level educators, not-for-profit organizations, state departments of education and natural resources, and the business community. This council will help ensure that federal environmental education efforts are balanced, relevant and cost-effective.

In addition, a National Environmental Education and Training Foundation has been established. The foundation will be an important ongoing source of private funds for environmental education activities, and will participate with domestic and international organizations to further environmental education and training worldwide.

GOVERNMENT

Government agencies at the federal, state and local levels have been actively involved in developing environmental education programs. One successful partnership of the federal, state and local governments is the Cooperative Extension System, which provides informal education programs on a variety of topics concerns including agriculture, natural resources and environmental management.

Federal

Almost all federal agencies are involved in aggressively supporting environmental education activities. Among the major agencies supporting environmental education are the EPA; the Department of the Interior, the Smithsonian Institution; the Departments of Agriculture, Commerce, Health and Human Services, Energy and State; the National Aeronautics and Space Administration; the Peace Corps and the Tennessee Valley Authority. Specific department activities in environmental education range from one-on-one training for farmers by the Cooperative Extension Agency to traveling environmental exhibits created by the Smithsonian Institution, from environmental education workshops in developing countries conducted by the Peace Corps, to interpretive and educational programs provided by the National Park Service, the Fish and Wildlife Service, and other Interior Department bureaus to marine education in coastal and ocean areas at the National Marine Sanctuaries.

Several groups exist to coordinate various aspects of the federal environmental education effort. The National Environmental Education Act established a federal Task Force on Environmental Education, which has already met several times to help advise the newly created Office of Environmental Education. In addition to the National Environmental Education Advisory Council established by the act, the National Advisory Council for Environmental Policy and Technology Subcommittee on Environmental Education and Training brings together educators, corporate executives, researchers, and state, local and federal environmental officials to

advise the federal government on environmental education and training policies.

In response to concerns about a national decline in math and science literacy, which are fundamental to environmental literacy, the federal government formed a Committee on Education and Human Resources—under the Federal Coordinating Council on Science, Engineering and Technology—to improve pre-college training of mathematics and science. For example, the Department of Energy permits staff to volunteer in schools, and opens federal laboratories and facilities to students and teachers.

THE COOPERATIVE EXTENSION SYSTEM

The Cooperative Extension System is a partnership of federal, state and local governments designed to develop and deliver non-formal education programs for youth and adults in each of the nation's 3,150 counties. The programs provide clients with research-based knowledge that empowers them to solve community and individual problems. The system combines the cooperative efforts of almost 3-million local volunteers, with professional educators at land-grant universities throughout the United States, each county and the U.S. Department of Agriculture.

Program needs are identified by a process that involves client groups, local volunteers and leaders, and state and national Cooperative Extension System professionals. These programs are delivered to rural, suburban and urban audiences and address a wide array of topics including agricultural competitiveness and profitability, community resource and economic development, leadership and volunteer development, natural resources and environmental management, and nutrition, diet and health.

The system readily addresses emerging or current issues such as the impairment of the quality of water resources by agricultural chemicals and animal waste. Working collaboratively with other private and public organizations, the Cooperative Extension System has developed a water quality education component focusing on nutrient management, pesticide management, drinking water/wellhead protection and animal-waste management. Examples of programs and their impact include:

- In portions of Nebraska, where the leaching of nitrates from fertilizer could pose a groundwater problem, 70 nutrient management demonstrations on cooperating farmers' fields were used in an educational program to compare cost-effective, environmentally sound, best-management practices and conventional production practices. The effects of this program reduced the rate of application of nitrogen on corn by an average of 33.6 kilos per hectare on 120,000 hectares with no decrease in yield.

- In portions of Maine where the leaching or movement of pesticides pose a threat to both ground and surface water, educational programs on the timing and methods of application of insecticides and fungicides have resulted in 15 percent of the state's potato growers changing to band application methods. These changes in application methods led to reductions of 3,742 kilos and 22,453 kilos, respectively, in the use of insecticides and fungicides.

Another way the federal government encourages environmental education is by facilitating and recognizing environmental learning projects. In May 1990, for example, the first International Youth Environmental Action Forum promoted secondary-school student participation in environmental projects. At the forum, which was sponsored by the National Governors Association and the U.S. Environmental Protection Agency, young people from 19 countries and 47 states exchanged information and developed detailed action plans for projects to be implemented in their local communities.[4] The next forum will be held in 1992.

At the annual Presidential Environmental Youth Awards ceremonies the President honors young people from around the country for their role in launching projects which have led to environmental improvement. The 1990 award winners included a project to protect the rainforest conducted by members of the Uxbridge, Massachusetts High School Student Council. In addition to petitioning the United Nations to protect rainforests, the students raised funds to purchase and preserve valuable rainforest land in Belize.[5]

State and Local

In the past two decades, many state and local governments have provided critical leadership and support to the field of environmental education. From developing model curricula to creating interpretive centers, most state and local jurisdictions play an on-going role in formal and informal environmental education initiatives. For example, in many states, the curriculum is determined at the state level. In some states, the local government or school districts play a more substantive role. State and local funds are also used to assist with teacher-training efforts, evaluation and materials development.

During the 1970s most states had statewide environmental education coordinators to oversee and promote environmental education efforts within the formal school system. In many cases, environmental education was an added responsibility that did not receive adequate support and many of the coordinator positions disappeared. Now with renewed emphasis on environmental education, coordinator positions are making a comeback.[6]

Many states—including Wisconsin, Maryland, Pennsylvania, Arizona, Washington and Florida—are moving ahead with environmental education legislative initiatives. At present, educators are working to evaluate the effectiveness of these activities and help other states adopt similar measures. Maryland's statute requires environmental education to be taught at all school levels. Maryland state grants to local school systems help them implement the mandate. In addition, a Maryland state program funds 30,000 student-days per year of on-the-water and field-based environmental education relating to the ecologically and economically important Chesapeake Bay on the east coast of the United States.[7]

Some state governments also support environmental education through the state natural resources agencies. A majority of state education agencies cooperate with the state resources agencies in support of many national environmental education programs, including Project Learning Tree, cosponsored by the Western Regional Environmental Education Council and the American Forest Foundation, and Project WILD, cosponsored by the Western Regional Environmental Education Council and the Western Association of Fish and Wildlife Agencies.

Despite this high level of state commitment to environmental education, that commitment has yet to be reflected in the substance of most classroom activities. Criteria for testing the effectiveness of environmental education are rare, and much of the progress to date in this area is a function of an individual teacher's initiative rather than systematic program implementation.[8]

Native American tribal governments are generally responsible for implementing environmental regulations within established tribal boundaries. A number of tribes and Native American organizations are involved in creative programs to enhance the environmental literacy of their people and to develop the technical expertise necessary to support the complexities of managing their lands, water and other environmental resources.

Examples of innovative approaches include the Bureau of Indian Affairs' natural resources cooperative education program available at Haskell Indian Junior College in Lawrence, Kansas, the development of curricula to support documentaries on Native American history and culture, and the "whole language" approach wherein native language, history and culture are used to instruct students.

In addition, educators throughout the country are becoming increasingly aware of the value inherent in teaching students about the philosophies of Native American cultures and their traditional practices. These philosophies and practices passed down both orally and in writing to many generations, reflect the importance which Native Americans have placed on the beneficial and supportive relationship between humans and their environment.

CASE STUDY

ENVIRONMENTAL EDUCATION INITIATIVE PROGRAM

Wisconsin

The state of Wisconsin recently passed a model environmental education act creating an Environmental Education Initiatives program. The program targets citizens of all ages, in all sectors of the community, through a coordinating board, a grants program, a research center, teacher training and curriculum planning. The program's philosophy is to promote lifelong environmental education, through practical educational experiences and citizen participation in community environmental issues.

The most recent initiative of this cooperative effort among several state agencies, the University of Wisconsin, environmental educators, community organizations and the private sector was the creation of the Wisconsin Environmental Education Board. In addition, the state has established the Wisconsin Center for Environmental Education at the University of Wisconsin at Stevens Point. The Center's major function is in-service teacher training. The Center is also working with the Wisconsin Department of Public Instruction to develop a program to assess the environmental literacy of the state's teachers and students.

Wisconsin schools were directed in 1985 to develop written, sequential curriculum plans for all subject areas. They were further directed to incorporate environmental education into all these curriculum plans, with the greatest emphasis in art, health, sciences and social sciences education. A model publication, *A Guide to Curriculum Planning in Environmental Education*, was released in 1985 to aid in this effort. More than 12,000 copies have been distributed throughout the United States and in 28 other countries.

SCHOOLS

In the United States, formal education is primarily the responsibility of state and local government. A United Nations report outlined the role of government at all levels "to promote environmental education, especially of the younger generation, as well as other measures to increase awareness of the value of the environment."

Elementary and Secondary Education

Many elementary and secondary schools in the United States have some type of environmental education program; however, only a small percentage of students receive more than a rudimentary education in environmental and related natural sciences. Many teaching materials currently available are oriented toward a specific environmental problem; few promote a broader environmental and scientific literacy.

From state to state, and sometimes from school district to school district, the scope of environmental education programs varies greatly in concept, technique, resources and integration into the general curriculum. While some work has been done to infuse environmental education into existing school curricula, the major effort has gone into developing issue-specific curricula on themes such as energy, water quality, wildlife and acid rain. Such curricula give teachers the basic information needed to compile student materials and suggest activities which students can pursue.

At present, the utility of such tools is often limited by the time constraints imposed by the school calendar and a lack of adequate support and training for the teachers themselves. Efforts are currently underway to develop classroom materials in relatively new areas such as pollution prevention, the interrelatedness of ecosystems, and the impact of individual acts and decisions on the environment.

One exemplary secondary-school program is the Training Student Organizers Program of the Council on the Environment of New York City. The program teaches students about environmental issues and helps them to develop organizational skills and to involve their peers and neighbors in such projects as beach cleanups, noise-abatement campaigns, graffiti elimination, open-space preservation and paper recycling. To date, New York student organizers have worked with more than 275 community groups and schools in the development of more than 250 projects.[9]

In addition, the school-age population is exposed to environmental education in a variety of informal education activities. These include nature centers, camps, church retreats, and youth agencies such as Girl and Boy Scouts and "4-H" clubs as well as programs and materials made available by community and government agencies, environmental groups, industry and the media.

Higher Education

Colleges, professional schools and graduate schools serve as the foundation for an environmentally educated work force and environmentally informed decision-makers in all sectors of society. One of the major challenges to higher education is the scarcity of college-level faculty with the interdisciplinary background necessary to develop degree programs in environmental education and to ensure that graduates in all disciplines are environmentally literate.

A growing number of institutions are offering specialized degrees in environmental fields and are including environmental issues in other disciplines. Although market forces are likely to encourage more people to enter the field in the coming years, there may be a temporary shortage of skilled college graduates with training in environmental professions.

THE NATIONAL SEA GRANT COLLEGE PROGRAM

The National Sea Grant College Program was established in 1966 as the aquatic counterpart to the Land Grant University system. Twenty-nine Sea Grant programs in coastal and Great Lakes states, Puerto Rico and the U.S. insular areas of the Pacific comprise the core of the National Sea Grant College program network. In cooperation with 300 universities and affiliated institutions, the nationwide Sea Grant network sponsors university-based marine research in the basic biological sciences (such as biochemistry, genetics and microbiology), pathology, toxicology and pharmacology; law and policy studies; seafood science and technology; aquaculture; oceanography; and ocean engineering.

Articles for public education appear in newsletters and magazines such as the *Makai* (Hawaii Sea Grant Program), *Sea Grant in the Caribbean* (Puerto Rico and the U.S. Virgin Islands Sea Grant Program) *Nor'easter* (Connecticut, Maine, Massachusetts, New Hampshire, New York and Rhode Island Sea Grant Programs), and *Dreissena polymorpha, Information Review* (New York Sea Grant Institute). More technical information is provided through proceedings of conferences and workships. Sea Grant programs also develop formal educational materials and curricula for use by teachers in the educational system and the public through coopertive work with groups such as the National Marine Educators Association (NMEA), non-governmental environmental organizations, and various federal, state and local government agencies.

Training educators to teach environmental subjects is an important challenge. Current networks and information sources, such as the Educational Resources Information Center (ERIC) for science, math and environmental education (affiliated with Ohio State University) are oriented to support teachers who already have the interest, initiative, scientific literacy and personal time to use them.

The Tufts Environmental Literacy Institute, codeveloped by Tufts University in Massachusetts and Allied Signal, Inc., is the nation's first environmental education program which integrates environmental issues into undergraduate, graduate and professional school curricula. The five-year goal of this faculty-based program is to train 450 professors and teachers and, in turn, reach nearly 100,000 students with environmental instruction.[10]

Professional Training

Technical training programs for adults involved in environmental activities offer an excellent mechanism for environmental education. Such training programs have expanded as the scope of environmental regulations has grown. At present, these programs focus mainly on the technical aspects of regulatory compliance. This training does not typically dwell on the nature of the environmental problem underlying the specific regulation. Community and technical colleges have become increasingly active in providing training programs in the environmental field, offering specific degree programs for such careers as water/wastewater technician and course offerings on a variety of specific concerns.

Professional societies can continue to play an important role here, particularly where new approaches to education and training are needed. One example is the American Institute of Chemical Engineers which decided in 1990 to establish a Center for Waste Reduction Technologies. The center will be a focal point for research, education and information dissemination on innovative waste-reduction technologies. The goal is to build a strong

CASE STUDY
PUBLIC SCHOOLS
Jefferson County, Colorado

In the state of Colorado, the public schools of Jefferson County operate two outdoor laboratory schools in the Rocky Mountains near the state capital of Denver. At least 500,000 students have participated in the program since 1956. Each year about 10,000 students of about 11 years of age spend a full school week at either the Mount Evans or Windy Peak Outdoor Schools. Each child who is able pays a charge for room and board, but everything else is entirely paid by the school district. Six hours of instruction a day are held primarily outdoors, followed by evening programs at the residential facility. High school students who act as counselors to the younger students, receive academic credit in an Outdoor Education Leadership course.

The Outdoor Lab Schools work with each classroom teacher to determine the best curriculum for the group. Every student must enroll in core classes such as wildlife, forestry, aquatics, geology, ecology, soils and grasses, astronomy, and map and compass reading. Elective classes are offered in lifetime sports such as archery, hiking, flycast fishing, backpacking and photography. In good weather, students may camp and learn to cook outdoors. A survey conducted of high school seniors in 1981 revealed that 84 percent of the students considered this to be the most significant experience of their school careers.

foundation for a wide range of industries as they develop the next generation of clean, economically competitive, processing and manufacturing facilities.

NON-GOVERNMENTAL ORGANIZATIONS

Private non-governmental organizations play a major role in environmental education activities and help elevate public awareness and increase environmental literacy in the United States. Protection of the environment, in its broadest sense, requires that informed citizens become involved in the democratic process. Citizen activists are at the core of many effective environmental education projects. From mobilizing residents around local development issues to planting trees to serving on school boards, individual citizens can be a powerful force for environmental education. Nearly eight percent of adult Americans contribute to an environmental organization, making the environment one of the nation's largest interest group concerns.[11]

For years, environmental advocacy organizations such as the Sierra Club, the Cousteau Society, the National Audubon Society, Ducks Unlimited, the Izaak Walton League and the National Wildlife Federation have invested in efforts to improve the public's understanding of environmental problems and alternative approaches to solutions. The National Wildlife Federation, for example, reaches an extensive youth audience with its monthly publication, *Ranger Rick*. Other organizations including the American Water Resources Association, the American Society of Civil Engineers, the Soil and Water Conservation Society, the American Geological Institute, and the National Science Teachers Association support major efforts in Earth science and mathematics oriented towards environmental issues.

Non-governmental education organizations, operating at the national level, have played an important and focused leadership role in promoting environmental education initiatives and providing support to all segments of

society. These visible and effective organizations are the North American Association for Environmental Education (NAAEE), the Alliance for Environmental Education (AEE) and the National Marine Educators Association (NMEA).

NAAEE is the largest professional environmental education organization in the United States. This 20-year-old association, with 1,500 members throughout the United States, Canada and Mexico, seeks to create a healthy, sustainable environment through education by supporting the professional efforts and growth of its members. NAAEE plays a key role in both representing the interests of environmental educators and teaching effective environmental education techniques and resources. It achieves these objectives through publishing research, conducting conferences and workshops, producing teaching materials, and providing a forum for the exchange of ideas and information.

The Alliance for Environmental Education, established in 1972, serves as an advocate for a quality environment through education and advances communication, cooperation and exchange among organizations concerned with environmental education. The National Network for Environmental Education, a program sponsored by AEE, consists of more than 100 centers throughout North America that assesses needs and provides services in teacher training, program development, community outreach, and research and evaluation.[12]

Marine environmental education is an important activity in many non-governmental organizations. Through its 15 chapters in the United States, members of the National Marine Educators Association exchange ideas and information at conferences and in its publications, *Current, the Journal of Marine Education* and *NMEA News*.

Approximately 30 to 35 million people visit U.S. aquariums and oceanariums annually. The Chesapeake Bay Foundation develops programs aimed at increasing public awareness and participation in protecting the bay. Among other activities, the Center for Marine Conservation develops materials for use in general ocean and coastal educational activities. The federal government also provides funding for the development of marine education materials. For example, the National Science Foundation, the National Sea Grant Program, the U.S. Fish and Wildlife Service and the EPA, among others, fund projects through various cooperative programs as well as sponsor their own educational programs.

Several non-governmental organizations also recognize outstanding efforts in environmental education activities. For example, NAAEE offers annual awards to honor educators, researchers, teachers and industry leaders; the National Wildlife Federation offers a "Connie" Award to an Environmental Educator of the Year; and Keep America Beautiful, Inc. gives out awards for community improvement programs that maintain an ongoing effort to motivate individual responsibility and positive citizen action toward environmental improvement.

Since 1972, the U.S. environmental education community has organized into a series of multi-state regions for the purpose of coordination and collaboration:

- The Western Regional Environmental Education Council includes the 13 Western states. Since their inception, they have supported the development of Project Learning Tree, Project WET (Water Education for Teachers) and Project WILD. Both of these successful curriculum projects are available in all 50 states, as well as Canada, Mexico and other countries.

- The Southern Regional Environmental Education Council which includes 13 Southern states, was formed in 1979 and was fashioned after the Western Regional Environmental Education Council.

- The Midwest Environmental Education Consortium encompasses Illinois, Iowa, Minnesota and Wisconsin. On a rotating basis, these states host an annual conference in environmental education for Midwest teachers and educators.

- The New England Environmental Education Network which includes six New England states, was formed in 1977 with funding from the U.S. Department of Education. It continues to serve a variety of educational needs relating to the environment.

Over 48 statewide organizations exist in the United States that focus on environmental and/or outdoor education. In some states more than one organization exists; for example, the Michigan Association for Outdoor and Environmental Education and Michigan Alliance for Environmental Education both play key roles. Many organizations sponsor annual conferences, publish newsletters, conduct workshops, support local initiatives and assist with efforts to legislate environmental education. Colorado's Alliance for Environmental Education and the Colorado Department of Education have created a database of environmental education resources which, when fully operational, will be available through local libraries, colleges and personal computers throughout the state.

In addition to formal educational settings such as outdoor schools and laboratories, both children and adults are exposed to environmental education in a variety of local educational activities programs, such as those offered by nature centers, camps, churches and youth agencies. They also have access to programs and material made available by local government agencies, environmental groups, the media and community organizations.

Many state, national and local non-governmental organizations have also initiated programs aimed at increasing environmental literacy of urban youth and children at risk. For example, Earth Corps, a program developed by the Metrocenter YMCA of Greater Seattle, Washington, and the Natural Guard, founded by Richie Havens, an American folk singer, work directly in the neighborhoods to involve urban youth in environmental projects.

INDUSTRY

Many industries, corporations and non-governmental organizations have become involved in environmental education. Independently and in partnership, numerous organizations are funding the development and implementation of innovative environmental education materials and programs for schools and communities. Corporations have supported activities such as teacher training institutes, curriculum development projects, tree-planting initiatives and media events.

Increasingly, corporations and non-governmental organizations are collaborating with federal, state and local agencies, and universities on environmental projects:

- Since 1973, the forest products industry has underwritten international environmental education efforts through the development and implementation of Project Learning Tree.

- The Edison Electric Institute sponsors environmental education programs and provides financial support for the North American Association for Environmental Education annual conference.

- Chevron is one of several companies directly involved in improving the curriculum for environmental studies, having supported the development of a science curriculum on chemicals and a family science curriculum for minorities and women through the Lawrence Hall of Science at the University of California at Berkeley.

- The *Times Mirror Magazines* embarked on a partnership for environmental education, whereby a percentage of advertising funds received will be donated to environmental education programs.

- Early in 1990 General Motors and the Environmental Protection Agency cooperated to produce an environmental education video and teacher's guide. This educational package was distributed to more than 72,000 elementary schools.[13] Subsequently, in cooperation with the U.S. Information Agency, the video is being translated into many languages and distributed throughout the world. The video package also has been used in Poland to teach English to environmental scientists.

CASE STUDY

THE DOLPHIN DEFENDERS

St. Louis, Missouri

The "Dolphin Defenders" are a group of 10- to 12-year-old inner-city children in St. Louis, Missouri. This Christian group of 35 young citizens devoted to environmental stewardship chose their name in part because of concerns about dolphins, but primarily to recognize dolphins' exemplary characteristics: dolphins are intelligent, live in a social group, turn predators away with nose bumps instead of bites, and will even die before abandoning another dolphin in distress. In emulating this behavior, the Defenders acquire environmental knowledge and share it with others to raise environmental literacy. One vehicle is the monthly *Dolphin Defender News*, which is written by the children and has a circulation of about 200, including 108 adult lifetime members.

The Dolphin Defenders' strongest message comes from their very broad action agenda. In about the last 12 months, they have recycled over 1,350 kilos of aluminum cans, over 585 kilos of steel cans, over 4,050 kilos of glass, over 1,125 kilos of paper, 22.5 kilos of scrap copper, and 405 kilos of cast iron. The Defenders' philosophy of saving energy is reinforced by the members' resolution to walk anywhere they go as a group that is under eight kilometers one way. They have been actively involved in lake and park cleanups and tree plantings. They also served as coordinators of the Environmental Olympics at the St. Louis celebration of Earth Day 1991 and have raised money for several special environmental initiatives.

COMMUNICATIONS MEDIA

Residents of the United States live in an information-rich environment. Their daily lives are saturated with information—substantive, commercial, political and entertaining. Within this context, efforts to improve environmental literacy must be designed to compete with the myriad of other messages vying for attention.

Environmental electronic media have grown rapidly, with environmental programming featured on TV, radio, video and computer formats. For example, no fewer than two-thirds of the top 25 Public Broadcasting System programs are nature and environmental documentaries.[14] And National Public Radio has started airing a national environmental talk show called "Good Dirt," which looks at environmental issues, action and education.

The Environmental Media Association (EMA), founded in 1989, is a non-profit organization serving the entertainment industry as a clearinghouse for environmental information and expertise. EMA works with writers, producers, directors and others in the creative community to encourage the incorporation of environmental themes in film, television and music. EMA has worked with more than 60 primetime television programs, specials, movies and feature films, and has hosted a number of industry-wide environmental forums. Through entertainment, EMA's environmental information has reached millions of people worldwide.[15]

In addition, there has been a steady increase in environmental articles in newspapers and weekly news magazines, as well as an increase in magazines and periodicals devoted specifically to the environment. For example, in the past few years, *Buzzworm*, *Garbage* and *E: The Environmental Magazine* have joined the more traditional nature and science publications put out by organizations such as the National Geographic Society, the Audubon Society and the Cousteau Society. Other magazines such as *Good Housekeeping*, *Popular Mechanics* and *Science* feature regular columns or frequent articles on environmental issues. Books focusing on the environment have also seen a meteoric rise, including such best-selling titles as *50 Simple Things You Can Do to Save the Earth* and *State of the World.*

Advertising has begun to feature the environmental advantages of one product over another. A number of industries with high public visibility, such as fast-food restaurants and grocery chains, have launched environmental programs. These programs have at least an indirect impact upon public environmental consciousness and have provided consumers with information to make responsible choices.

ISSUES IN ENVIRONMENTAL EDUCATION

Although the field of environmental education has made progress recently, there are many specific areas that need to be addressed, including:

Risk Communications. Frequently there are significant differences between scientific evaluations of environmental and health risks and the perceptions of the public. Bridging this gap presents an important challenge for environmental education. Since environmental policies and priorities are established through the political process with public participation, the public's ability to understand and discuss risks with policymakers is important for sound public policy.

Target Populations. Another unresolved issue is the extent to which formal environmental education efforts are aimed at all sectors of the population. At present, the federal focus is primarily elementary and secondary students, with some support for community colleges, vocational and higher education activities. The immediacy of today's environmental problems raises the question of how the government programs might better address the adult population.

Teacher Training. While most U.S. institutions of higher learning with a degree program in education or natural resources offer at least one course in environmental education, only a few offer a specialization in the field. Finding out about current environmental education materials and having the resources to purchase and receive training in their use is a challenge for most teachers. Both pre-service and in-service training for teachers need to be strengthened.

Curriculum Development. In the past two decades, many environmental education curricula initiatives focused on developing supplementary materials with a thematic approach, such as energy and water quality. While such materials provide an excellent learning tool, many teachers find it difficult to find time to present them within the school calendar. More recently, there have been increasing efforts to help teachers infuse environmental education into all subject areas.

Curriculum Content. Within the professional education community there is considerable debate as to the extent to which values ought to be a part of an environmental education curriculum. While some believe that environmental education is largely synonymous with improved scientific and technical literacy, others argue that citizens must not only learn about the environment, they must learn how to value it, and to take actions to care for it.

Research and Evaluation. Environmental education initiatives should place a greater emphasis on evaluation of outcomes to determine if changes to education and literacy really are occurring and to ensure that programs are developed which meet desired objectives.

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PART IV

APPENDICES

APPENDIX A

ENVIRONMENTAL RESPONSIBILITIES OF THE U.S. LEGISLATIVE BRANCH

The legislative branch of the U.S. federal government consists of two democratically elected bodies, or chambers: the Senate, which is composed of 100 members, two elected at large from each state; and the House of Representatives, which consists of 435 members, elected from single-member districts of approximately equal population established by the state legislatures. The Commonwealth of Puerto Rico, the territories of Guam, the Virgin Islands, American Samoa and the District of Columbia are also represented by delegates in the House of Representatives who do not vote directly on legislation.

The two chambers, the Senate and the House of Representatives, (the latter chamber is usually called simply "the House"), have generally equal functions in the making of laws, including environmental laws. Environmental proposals, like other laws, may be initiated by members of either chamber, by the executive branch, or by citizens, groups or associations through petition to their elected representatives. After being introduced by members of either chamber, such proposals, known as bills, are referred to specialized committees and subcommittees. For example, a bill may be referred to specific subcommittees concerned with marine matters, forestry, agriculture, water resources, toxic substances, wastes, energy, mining, public lands or other environmental issues.

Committees and their subcommittees, where most legislative work takes place, hold public hearings to receive written and spoken testimony on bills from other members, from representatives of the executive branch, persons with special interest or expertise and the public. The committees review the comments received, deliberate and make changes in the bills. When a committee has finished its consideration, it reports the bill to the chamber floor for further debate by the full membership of that chamber. Differences between bills originating in each chamber are usually resolved in formal conferences between the two chambers.

To become law, a bill must be approved by the majorities of both chambers. In addition, it must be signed by the President; or, if the bill is opposed by the executive branch, the President may veto the bill. If a bill is vetoed, it may still be enacted into law, but only if it is then approved by a two-thirds majority of each chamber. A bill can also become a law without the President's signature if Congress is in session and the President chooses not to veto it; if Congress is not in session the President may "pocket" the bill and thus veto it without sending it back to the Congress.

The legislatures of the several states have also enacted a significant body of environmental legislation. In certain instances states have been delegated the authority to implement federal programs under state statutes.

A list of major federal environmental laws is provided in Appendix D.

APPENDIX B

ENVIRONMENTAL RESPONSIBILITIES OF THE U.S. EXECUTIVE BRANCH

THE PRESIDENT

White House Office
Overall Policy; Agency Coordination

Agencies of the Executive Office of the President

Council on Environmental Quality
Environmental Policy; Agency Coordination

Office of Management and Budget
Budget; Agency Coordination and Management

Office of Science and Technology Policy
Science and Technology Policy; Agency Coordination

Executive Departments and Independent Agencies

Department of Agriculture
Forestry; Soil Conservation; Research; Wilderness Areas

Department of Commerce
Oceanic and Atmospheric Monitoring and Research; Management of Living Marine Resources; Coastal Zone and Marine Sanctuary Management; Marine Pollution, Response and Damage Assessment.

Department of Defense
Civil Works Construction; Dredge and Fill Permits; Pollution Control from Defense Facilities

Department of Energy
Energy Policy; Coordination; Petroleum Allocation; Research and Development

Department of Health and Human Services
Public and Environmental Health-related Concerns

Department of Housing and Urban Development
Housing; Urban Parks; Urban Planning

Department of the Interior
National Parks; Natural Wildlife Refuges; Bureau of Land Management; Public Lands; American Indian Trust Lands; Water Resources; Fish and Wildlife; Outer Continental Shelf; Exclusive Economic Zone; Energy and Minerals; Mined Land Reclamation; Mine Health and Safety Research; and Natural Hazards.

Department of Justice
Environmental Law and Litigation

Department of Labor
Occupational Health

Department of State
International Environmental Matters, in cooperation with other federal agencies

Department of Transportation
Mass Transit; Roads; Airplane Noise; Oil Pollution

Environmental Protection Agency
Air and Water Pollution; Solid and Hazardous Waste; Radiation; Pesticides; Noise; Toxic Substances; Health; Environmental Education

Federal Energy Regulatory Commission
Transmission and pricing of electricity and hydroelectric licensing

Marine Mammal Commission
Marine Mammal Protection

National Aeronautics and Space Administration
Atmospheric and Space Science Research and Coordination

National Science Foundation
Science Research Funding and Coordination

Nuclear Regulatory Commission
Nuclear Power Licensing and Regulation

Tennessee Valley Authority
Electric Power Generation and Water Resource Management

U.S. Agency for International Development (USAID)
Development Assistance

Other Associated Organizations

Inter-American Tropical Tuna Commission
Tuna Fisheries

International Boundary and Water Commission (U.S. and Mexico)
Trans-border Water Quality Matters

International Joint Commission (U.S. and Canada)
Great Lakes and other Trans-border Environmental Matters

South Pacific Commission
Pacific Island Affairs

U.S.-Panama Joint Commission on the Environment of the Panama Canal
Panama Canal Environment

APPENDIX C

THE U.S. COURT SYSTEM

In the United States, most environmental cases are litigated in the federal courts. The federal court system is established under provisions in the federal Constitution, and co-exists with the system of state and local courts established under the constitutions and laws of each of the states.[1] The federal court system is essentially a three-tiered system. Cases usually enter the system at the district court level, and appeals are usually first heard at the appellate or circuit court level. There are 94 federal districts courts, organized into federal circuits. There are 13 federal appeals courts in the United States. The U.S. Supreme Court is the second and final appellate level. The nine justices of the Supreme Court, and all of the judges of the federal district and appellate courts, are appointed by the President, with life tenure, upon the advice and consent of the United States Senate.

Cases arising under the environmental laws of the United States generally enter the judicial system at the district court level; however, appeals from decisions of administrative law judges may proceed directly to the courts of appeals.[2] In addition, some specialized disputes between states over matters pertaining to water allocations can be brought directly to the Supreme Court. Although several specialized federal courts of appeals deal with specific types of controversies, there is no separate federal court for environmental matters.

The process of filing civil environmental cases in the federal court system is generally the same as for other types of civil actions. Complaints brought on behalf of the federal government to enforce federal environmental laws are filed by the attorney general or his designate. Any other person (regardless of citizenship) also may file a complaint alleging an environmental grievance. The plaintiff must allege that the matters complained of fall within the federal court's limited jurisdiction. The defendant named in the complaint may then file an answer admitting or denying the plaintiff's allegations. Through a process called "discovery," each party may seek to obtain from the other party documentary and other information pertaining to the allegations, which the parties may then seek to use in support of their respective positions.

Over 90 percent of all federal civil cases, including environmental cases, are settled by mutual agreement or otherwise disposed of without proceeding to a trial. If, however, a case proceeds to trial, then the trial can be held before a jury selected by the parties, or simply before the judge. At the trial, each side may present evidence, including testimony by lay and expert witnesses, and each side has the opportunity to cross-examine the witnesses presented by the other

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[1] The state courts are courts of general jurisdiction and handle a wide range of civil and criminal matters. Appeals within a state court system can be to the U.S. Supreme Court if the appeal involves a question of federal statutory or constitutional law, but if the appeal involves only state law issues, then it may be taken to the highest court of appeal of that state.

[2] Administrative law judges handle administrative matters arising from determinations made by federal agencies. Unlike federal judges, administrative law judges are employees of the agency for which they work. There are approximately 1,150 federal administrative law judges. Several federal agencies handling environmental matters rely on administrative law judges to resolve most disputes at the administrative level. Because appeals from those administrative determinations may proceed directly to the federal appellate courts, a significant percentage of the appellate courts' caseload involves environmental matters.

side. Environmental trials often involve extensive testimony by expert witnesses on scientific or technical matters in dispute. After the presentation of the evidence, the judge instructs the jury (if the case has been tried before a jury). The jury decides questions of fact, and the judge rules on questions of law. If the case is not tried by a jury, the judge will decide all issues of fact and law. To prevail in environmental cases involving disputes over factual matters, the plaintiff must meet a "preponderance of the evidence" standard; that is, the plaintiff must show that it is more probable than not that events occurred as the plaintiff alleges. In environmental challenges to federal agency decision-making, the plaintiff typically must demonstrate that the agency's decision was arbitrary, capricious or not in accordance with law.

Sanctions and relief in civil cases may include monetary penalties, awards of damages, and injunctive and declaratory relief. Using their injunctive powers, the courts in environmental cases may direct, for example, that pollution cease, that contaminated sites be cleaned up, or that environmental impacts be assessed before a project proceeds or, in some cases, litigants may settle on an agreement that a defendant will undertake projects beneficial to the environment.

Criminal cases under the federal environmental laws may be brought only by the government, via the attorney general or his designate. State attorneys general also initiate criminal environmental actions. A criminal investigation can lead to an arrest or indictment, followed by an arraignment, where the defendant must enter a plea of guilty not guilty, or no contest. In environmental crimes cases, as in all other criminal cases, the government must prove the defendant guilty beyond a reasonable doubt. Criminal sanctions in environmental cases, as in other types of criminal cases, may include fines and imprisonment.

APPENDIX D

NATIONAL ENVIRONMENTAL LEGISLATION

(Selected Listing)

GENERAL

- ***The National Environmental Policy Act of 1969***
  -Requires that all federal agencies prepare environmental impact statements for federal actions significantly affecting the quality of the human environment.

- ***Environmental Quality Improvement Act of 1970***
  -Establishes national policy of enhancement of environmental quality through state and local governments, encouraged and supported by the federal government.

AIR QUALITY

- ***Clean Air Act and Amendments of 1990***
  -Sets national ambient air quality standards and state implementation plans.
  -Sets new source performance standards and hazardous air pollutants standards.
  -Provides for federal enforcement mechanisms.
  -Creates allowance program to reduce national utility sulfur dioxide emissions, reduce other hazardous air pollutants from industrial sources, further reduce pollutants from automobiles and other contributors to urban smog, and phase out the production and use of ozone-depleting substances.

- ***Radon Gas and Indoor Air Provisions***
  -Provides for EPA report to Congress on locations and levels of radon gas, ways to minimize its threats and public education about its hazards.

WATER QUALITY

- ***Clean Water Act, 1972, as amended by the Water Quality Act, 1987***
  -Initiates a new joint state-federal program to control non-point source pollution.
  -Accelerates imposition of tighter controls on toxic pollutants.
  -Regulates discharges of pollutants; prohibits point source discharge of solids in effluent.
  -Prohibits destruction of regulated wetlands without mitigation.
  -Funds construction of sewage treatment facilities.
  -Supports the purpose and objectives of the U.S.-Canada Great Lakes Water Quality Agreement.

- ***Safe Drinking Water Act (1974) and Amendments of 1977 and 1986***
  -Provides for setting maximum contaminant level goals and national primary drinking water regulations for public water systems.

WETLANDS

- ***Clean Water Act § 404***
  -Authorizes the U.S. Army Corps of Engineers to issue permits for the discharge of dredged or fill material into waters of the United States.

- ***The Emergency Wetlands Resources Act of 1986***
  -Intensifies cooperative and acquisition efforts among private interests and federal, state and local governments for the protection, management and conservation mapping and inventory work of the nation's wetlands and to prepare reports on the status and trends of wetlands in the United States.

- ***The North American Wetlands Conservation Act of 1989***
  -Encourages partnership among public agencies and other interests to protect, enhance, restore and manage an appropriate distribution and diversity of wetland ecosystems and other habitats for migratory birds and other fish and wildlife in North America.

- ***The Coastal Wetlands Planning, Protection and Restoration Act of 1990***
  -Authorizes wetlands restoration activities for Louisiana, a national coastal grants program, and increased funding for coastal wetlands conservation projects authorized by the North American Wetlands Conservation Act.

- ***The Food Security Act of 1985/Food, Agriculture, Conservation and Trade Act of 1990 (Farm Bills)***
  -Encourages removal of fragile lands from agricultural production and provides various opportunities for wetland habitat protection and restoration, while reducing federal agricultural subsidy costs.

MARINE AND COASTAL RESOURCES

- ***Anadromous Fish Conservation Act (1965)***
  -Authorizes programs to conserve, develop and enhance federal anadromous fisheries resources.

- ***Atlantic Striped Bass Conservation Act (1984)***
  -Authorizes programs for the conservation and management of Atlantic striped bass.

- ***Coastal Barrier Resources Act***
  -Prohibits development of barrier islands within the Coastal Barrier Resource System to conserve fish, wildlife and other natural resources in those areas.

- ***The Coastal Barrier Improvement Act of 1990***
  -Amends the Coastal Barrier Resources Act of 1986, which established the Coastal Barrier Resources System consisting of undeveloped coastal barriers and other areas located on the coasts of the United States.

- ***The Coastal Zone Management Act of 1972***
  -Makes federal funds available to encourage states to develop comprehensive management programs in an effort to increase the effective management, beneficial use, protection and development of the coastal zone.

- ***Driftnet Impact Monitoring, Assessment and Control Act of 1987***
  -Directs the government to assess and minimize the adverse effects of driftnets in the North Pacific ocean on marine resources.

- ***Fish and Wildlife Act (1956)***
  -Establishes a comprehensive national fish and wildlife policy to develop measures for maximum sustainable yield to insure stability of domestic fisheries.
  -Provides for agency consultation with the Fish and Wildlife Service (FWS) whenever the "waters of any stream or other body of water are to be impounded, directed or otherwise controlled."

- ***Fish and Wildlife Conservation Act ("Non-game Act")***
  -Requires the Fish and Wildlife Service to monitor and assess non-game migratory birds, and identify those likely to be candidates for listing as endangered species.

- ***Fish and Wildlife Coordination Act (1934)***
  -Authorizes FWS and National Marine Fisheries Service to assist federal, state and other agencies in developing, protecting, rearing and stocking fish and wildlife on federal lands.

- ***Fisherman's Protective Act ("Pelly Amendment") of 1967***
  -Ensures that foreign fishing activities are in accordance with international fishery conservation program, and activities do not affect endangered/threatened species.

- ***Fur Seal Act Amendments of 1983***
  -Prohibits taking of fur seals, with exception of subsistence harvest by Alaska Natives.

- ***Lacey Act Amendments of 1981***
  -Prohibits commerce of fish and wildlife in violation of federal, state and international laws.

- ***Magnuson Fishery Conservation and Management Act (1976)***
  -Conserves and manages fishery resources within the U.S. Exclusive Economic Zone (EEZ) for maximum sustainable yield.
  -Creates eight regional fishery management councils to prepare fishery management plans for their respective regions.

- ***Marine Mammal Protection Act of 1972, and Amendments of 1988***
  -Provides for long-term management, research, conservation and recovery programs for marine mammals.
  -Establishes a moratorium on the taking and importing of marine mammals and marine mammal products.

- ***Shore Protection Act of 1988***
  -Requires vessels to protect coastal areas from disposal of solid waste.

- ***Outer Continental Shelf Lands Act (1953) and Amendments of 1978 and 1985***
  -Regulates offshore oil, gas and mineral leasing.
  -Requires compliance with natural resource protection programs from damages associated with oil, gas and mineral development activities.

- ***Saltonstall-Kennedy Act (1939)***
  -Establishes fisheries research and development fund.

- ***South Pacific Tuna Act of 1988***
  -Regulates tuna harvest by U.S. flag vessels within the Exclusive Economic Zones of Pacific Island Parties.

MARINE POLLUTION CONTROL

- ***National Ocean Pollution Planning Act, 1978***
  -Establishes a comprehensive five-year plan for federal ocean pollution research and development and monitoring programs, and coordinates research of the Great Lakes and estuaries of national importance.

-Develops an information base for use in conservation, equitable distribution and development of ocean and coastal resources.

- ***Oil Pollution Act of 1990***
  -Increases and extends civil and criminal liability limits for the cleanup of oil spilled from vessels.
  -Requires better planning and preparedness and measures to increase navigation safety, new standards for vessel construction, crew licensing and manning of vessels.

- ***The Act to Prevent Pollution from Ships (1980)***
  -Implements international agreement "Convention for the Prevention of Pollution by Ships" (MARPOL Annexes I-V).
  -Prevents pollution from ships by the discharge of harmful substances or effluent.

- ***Marine Pollution and Research and Control Act, 1989***
  -Implements the provisions of MARPOL Annex V.
  -Prohibits the disposal of plastics at sea by any vessel within the U.S. EEZ.

- ***Ocean Dumping Ban Act (ODBA) of 1988***
  - Prohibits issuance of new permits for dumping of sewage sludge or industrial wastes into ocean waters; existing sewage sludge or industrial waste dumping (existing permittees) under compliance schedules/enforcement agreements to phase out dumping activities. Statutory deadline December 31, 1991.

- ***Columbia River Basin Fishery Development Program ("The Mitchell Act") (1938)***
  -Establishes cultural stations and funds programs to facilitate conservation of Columbia River fishery resources.

- ***Marine Protection, Research and Sanctuaries Act (Title I, II, and III)***
  -Prohibits ocean dumping of wastes generated on land.
  -Authorizes designation of marine sanctuaries. (Eight National Marine Sanctuaries are currently designated; seven more are proposed).

LAND MANAGEMENT

- ***Soil and Water Resources Conservation Act of 1977***
  -Provides for periodic appraisal of the soil, water and related resources of the nation; findings of the appraisal are used by the Department of Agriculture to develop soil and water conservation programs for the non-federal lands of the nation.

- ***Renewable Resources Extension Act of 1978***
  -Provides for coordination of various extension activities for private forest and range landowners and processors, and consumptive and non-consumptive users of rangeland renewable resources.

- ***Public Rangelands Improvement Act of 1978***
  -Establishes national commitment to improve the condition and productivity of the western grazing lands.

- ***Food, Agriculture, Conservation and Trade Act of 1990***
  -Successor to the Food and Security Act of 1985; places increased emphasis on increasing U.S. competitiveness in world markets.

- ***Surface Mining Control and Reclamation Act of 1978***
  -Establishes nationwide mining and reclamation standards and practices, requires federal/state cooperation, including providing state oversight authority on surface coal mining and reclamation, creates the Office of Surface Mine Reclamation and Enforcement, and establishes the abandoned mine reclamation fund.

- ***Multiple-Use Sustained-Yield Act of 1960***
  -Directs the secretary of Agriculture to utilize national forests in a combination that best meets the needs of Americans, without impairment of the land's productivity.

- ***Forest and Rangeland Renewable Resources Planning Act of 1974***
  -Requires a periodic federal government assessment of the condition of renewable resources on all lands and development of a program to respond to the assessment's findings.

- ***National Forest Management Act of 1976***
  -Requires a formal, ongoing planning and evaluation process for the management of the national forests.

- ***Cooperative Forestry Assistance Act of 1978***
  -Provides technical and financial incentives to private land owners for forest management and other assistance through state forestry programs.

- ***The Food Security Act of 1990 (Farm Bill)***
  -Provides resources for tree-planting and conversion of idle cropland to forests.

- ***Mining and Minerals Policy Act of 1970***
  -Establishes federal policy of encouraging economic development of the mining industry, and methods of disposal, control and reclamation of mineral waste products and the reclamation of mineral land.

- ***Oil and Gas Reform Act***
  -Requires all lands to be offered competitively, and gives surface use plan of operation approval to the Forest Service for oil and gas actions on Forest Service lands.

- ***Mining Law of 1872***
  -Provides that all valuable mineral deposits in lands belonging to the United States are free and open to exploration and purchase, and those lands in which minerals are found are open to occupation and purchase by U.S. citizens.

- ***Public Rangelands Improvement Act of 1978***
  -Provides for improvement in the condition of public rangelands for the purpose of increasing production of livestock, wildlife habitat, recreation, forage, and water and for soil conservation.

- ***Mineral Leasing Act of 1920***
  -Establishes leasing system for deposits of mineral interests on federal lands.

- ***Wilderness Act of 1964***
  -Provides for designation of wilderness areas that shall be unimpaired for future use and enjoyment, and establishes the National Wilderness Preservation System.

- ***Taylor Grazing Act of 1934***
  -Established present grazing system on western grazing lands.

- ***Federal Land Policy and Management Act of 1976***
  -Among other provisions, establishes requirements for the management, exchange and withdrawal of public lands, and provides for the establishment of protected Areas of Critical Environmental Concern.

- ***National Forest Management Act of 1976***
  -Directs the government to manage national forests for multiple use and sustained yield.

- ***National Park Organic Act and Enabling Act for each Park Unit and Refuge System (1916)***
  -Establishes that 131 units of National Park Service and 152 National Fish Wildlife Lands are in coastal areas.

- ***National Wildlife Refuge System Administration Act of 1966***
  -Consolidated all refuge lands administered by the Fish and Wildlife Service into a single National System, thereby creating the National Wildlife Refuge System.

WILDLIFE

- ***Migratory Bird Treaty Act***
  -Prohibits unauthorized pursuit, hunt, taking, capture, kill, possession, trade or transport of any migratory bird included in terms of international conventions for the protection of migratory birds.

- ***The Endangered Species Act of 1973, as amended***
  -Provides for the conservation of threatened and endangered species of fish, wildlife and plants, and their critical habitats.

- ***Bald and Golden Eagle Protection Act (1940)***
  -Prohibits taking, possession or trade of bald or golden eagle subject to criminal and civil penalties.

- ***Wild Free-Roaming Horses and Burros Act (1971)***
  -Provides for the management and protection of unbranded and unclaimed horses and burros on public lands administered by the secretary of the Interior through the Bureau of Land Management.

TOXICS AND WASTES

- ***Federal Insecticide, Fungicide and Rodenticide Act (1947)***
  -Regulates distribution, sales and receipt of pesticides through registration with the Environmental Protection Agency.

- ***Hazardous Materials Transportation Act (1975), Amendments 1976***
  -Regulates handling and transportation in commerce of hazardous materials.

- ***Resource Conservation and Recovery Act of 1976***
  -Regulates standards necessary to protect human health and environment, applicable to generators and transporters of hazardous waste, and owners and operators of hazardous waste treatment, storage and disposal facilities.

- ***Comprehensive Environmental Response, Compensation and Liability Act of 1980 ("Superfund") and Superfund Amendments and Reauthorization Act of 1986 ("SARA")***
  -Imposes notification and public disclosure requirements on persons who handle, store or dispose of hazardous substances.
  -Establishes national hazardous substances response plan, including methods of determining priorities among releases, and provides for liability for response costs incurred by the government.
  -Imposes financial liability on companies for direct damages to individuals and natural resources.

- ***Toxic Substances Control Act (1976)***
  -Regulates the testing, manufacture, processing, distribution and handling of toxic substances.

- ***Emergency Planning and Community Right-to-Know Act of 1986 (Title III of 1986 SARA)***
  -Requires owners and operators of facilities containing extremely hazardous substances to notify the state emergency response commission, and requires joint preparation of emergency plan.

- ***Pollution Prevention Act of 1990***
  -Establishes waste management hierarchy with preference given to source reduction.

- ***Refuse Act of 1899 (§13 of the Rivers and Harbors Appropriations Act of 1899)***
  -Prohibits throwing, discharge or deposit of any refuse matter into navigable waters.

RIVERS

- ***Rivers and Harbors Act***
  -Restricts filling of, or construction on waterways that may affect living marine resources.

- ***Wild and Scenic Rivers Act (1968)***
  -Preserves selected rivers with remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural or similar values in their free-flowing condition.

- ***Submerged Lands Act, §3 (1953)***
  -Confirms that states hold the title to lands beneath navigable waters within the boundaries of the states, and the natural resources within such lands and waters.

MAJOR FEDERAL ENERGY LEGISLATION, 1970 - 1990

- ***Alternative Motor Fuels Act of 1988***
  -Requires the secretary of Energy to purchase alternative-fuels vehicles, study their performance and sell their fuel to the public.
  -Requires the secretary of Energy to study the use of alcohol and natural gas fuel in heavy duty truck engines and buses.

-Provides a Corporate Average Fuel Economy (CAFE) incentive for manufacturers of alternative-fuels vehicles.

- ***Powerplant and Industrial Fuel Use Act of l978***
  -Prohibits the construction or operation of new baseload powerplants that do not have the capability of using coal as their primary energy source.
  -Permits the secretary of Energy to prohibit the use of petroleum or natural gas in existing powerplants that have coal capability.

- ***Motor Vehicle Information and Cost Savings Act (1972),*** as amended by the Energy Policy and Conservation Act.
  -Requires the secretary of Energy to publish and distribute booklets containing data on the fuel economy of automobiles manufactured each year (the Gas Mileage Guides).
  -Requires the Department of Transportation to set the Corporate Average Fuel Economy standards for car companies and the Environmental Protection Agency to compile the information for the booklet.

- ***Energy Policy and Conservation Act (EPCA) (1975)***
  -Appliance Energy Conservation:
    --Requires the secretary of Energy to establish test procedures for determining the energy consumption of appliances, such as refrigerators and dishwashers.
    --Sets energy conservation standards for appliances and requires the secretary of Energy to review them periodically.
  -State Energy Conservation Program:
    --Requires the states to prepare energy conservation plans in order to receive financial assistance for eligible programs.
  -Schools and Hospitals Grant Program:
    --Authorizes the secretary of Energy to make grants for energy inspections and audits of and the instruction of energy conservation improvements in schools and hospitals.
  -Local Government Buildings and Public Care Institutions Grant Program:
    --Authorizes grants for conducting energy inspections and audits of local government buildings and public care institutions. (This program has not been funded for several years.)

- ***Energy Conservation and Production Act (EPCA) (1976)***
  -Utility Rate Design Initiatives:
    --Authorizes the secretary of Energy to fund demonstration programs on energy efficient electric utility operations.
  -Energy Conservation Standards for New Buildings.
  -Weatherization Assistance Program.

- ***National Energy Conservation Policy Act (NECPA) (1978)***
  -Residential Energy Conservation:
    --Established a program of home energy audits conducted by utilities and overseen by the states and the Department of Energy that terminated on June 30, 1989.

- ***Federal Coal Leasing Amendments Act of 1975 and 1976***
  -Allows competitive coal leasing only, establishes a royalty rate of 12.5 percent for all surface-mined coal, underground mined coal royalty rate to be established by regulation, and requires land use plans and public hearings prior to any leasing.

- ***Renewable Energy Industry Development Act of l983***
  -Committee is to evaluate the domestic renewable energy industry and promote exports of renewable energy technology.

- ***Geothermal Energy Research, Development and Demonstration Act of l974***
  -Establishes the Geothermalsolar Resources Development Fund.
  -Provides for loan guarantees to facilitate commercial development of geothermal resources.

- ***Federal Nonnuclear Energy Research and Development Act of l974***
  -Authorizes many forms of federal financial assistance and incentives, such as grants and cooperative agreements for fossil energy technology and resource development.

- ***Solar Energy Research, Development and Demonstration Act of l974***
  -Establishes a committee composed of federal agency representatives, including the Department of Energy, to conduct a regional and national appraisal of all solar energy resources and to initiate a research, development and demonstration program to assure use of solar energy.

- ***Solar Heating and Cooling Demonstration Act of l974***
  -Requires programs to be established in which the secretary of Energy participates for the development and demonstration of solar heating and cooling system for use in residential dwellings, for the development and demonstration of combined solar heating and cooling systems for use in commercial buildings, and for dissemination of the information developed.

- ***Electric and Hybrid Vehicle Research, Development,and Demonstration Act of l976***
  -Authorizes the department to develop a federal program of research, development and demonstration designed to promote electric vehicle technologies and to demonstrate the commercial feasibility of electric and hybrid (propelled by a combination of an electric motor and an internal combustion or other engine) vehicles.

- ***Solar Photovoltaic Research, Development, and Demonstration Act of l978***
  -Requires the secretary of Energy to establish an accelerated program of research, development and demonstration of solar photovoltaic energy technologies leading to early competitive commercial utilization.

- ***Public Utilities Regulatory Policies Act of l978, Title IV***
  -Provides for federal loans to cover licensing, feasibility study, and project costs in order to encourage the development of small hydroelectric power projects in connection with existing dams that are not being used to generate electric power.

- ***Automotive Propulsion Research and Development Act of l978***
  -Requires the Department of Energy to establish a program to assure the development of automobile propulsion systems that have less adverse environmental impact and less fuel consumption.

- ***Methane Transportation Research, Development, and Demonstration Act of l980***
  -Requires the Department of Energy to establish a methane vehicle research, development and demonstration program.

- ***Ocean Thermal Energy Conversion Act of l980 (OTEC)***
  -Requires the National Oceanic and Atmospheric Administration, in consultation with the Department of Energy, to establish procedures, including licensing requirements, for the location, construction and operation of ocean thermal energy conservation facilities and plant ships to produce electricity and energy-intensive products off the U.S. coast.

- ***Ocean Thermal Energy Conversion Research, Development, and Demonstration Act (1980)***
  -Requires the government to conduct a research and development program and authorizes the secretary of Energy to initiate a demonstration program for ocean thermal energy conversion.

- ***Wind Energy Systems Act of l980***
  -Requires the Department of Energy to carry out an accelerated program of wind energy research, development and demonstration.

- ***Energy Security Act (1980)***
  -Authorizes synthetic fuels production under Defense Production Act.
  -Provides incentives for the development of alcohol fuels, biomass energy, and municipal waste energy by making loans, loan guarantees, price guarantees and purchase agreements available for project financing.
  -Includes several initiatives to encourage development of renewable energy.

- ***Energy Reorganization Act of 1974***
  -Abolishes the Atomic Energy Commission and establishes the Nuclear Regulatory Commission.

- ***Nuclear Waste Policy Act of 1982, as amended by the Nuclear Waste Policy Amendments Act of 1987***
  -Provides for the disposal and storage of high-level radioactive waste and spent nuclear fuel.
  -Authorizes the secretary of Energy to characterize the repository site at Yucca Mountain, Nevada.
  -Specifies procedures for interim storage, transportation of wastes, research and development, and federal-state-Indian tribe coordination and cooperation.
  -Establishes the Office of Civilian Radioactive Waste Management.

- ***Low-Level Radioactive Waste Policy Act (1980) and Amendments Act of 1985***
  -Establishes state responsibility for providing disposal facilities for low-level waste generated within its borders, with certain federal wastes exempted.
  -Establishes federal responsibility for nuclear wastes greater than Class C.
  -Establishes procedures whereby states may enter into regional compacts to establish disposal facilities; these compacts require approval by Congress. (Nine regional compacts have been approved to date.)

- ***Uranium Mill Tailings Radiation Control Act of 1978***
  -Requires the secretary of Energy to assess and perform remedial action at inactive mill tailings sites until September 30, 1994.
  -Provides regulation of active mill sites in order to stabilize and control the tailings.

Other Environmental Legislation

Alaska Native Claims Settlement Act, 43 U.S.C. § 1601 *et seq.*

Alaska National Interest Lands Conservation Act of 1980, 16 U.S.C. §§ 3101 *et seq.*

Antarctic Conservation Act, 16 U.S.C. § 2401 *et seq.*

Antarctic Protection Act of 1990, 16 U.S.C. §§ 2461 to 2466.

Antarctic Living Marine Resources Convention Act, 16, U.S.C. §§ 2431 *et seq.*

Atlantic Salmon Convention Act, 16 U.S.C. § 3601 *et seq.*

Atlantic Tunas Convention Act, 16 U.S.C. § 971.

Deepwater Port Act of 1971, 33 U.S.C. § 1501 *et seq.*

Global Change Research Act of 1990, 15 U.S.C. §§ 2921 *et seq.*

The Historic Sites, Buildings and Antiquities Act of 1935, 16 U.S.C. §§ 461 to 467.

Migratory Bird Conservation Act, 16 U.S.C. §§ 715 to 715d, 715e, 715f to 715k, 715 to 715r.

The National Historic Preservation Act of 1966, 16 U.S.C. § 470 *et seq.*

National Ocean Pollution Planning Act, 33 U.S.C. §§ 1701 *et seq.*

National Park Service Act, 16 U.S.C. §§ 1 to 4.

The Noise Control Act of 1972, 42 U.S.C. § 4901 *et seq.*

Northern Pacific Fisheries Act, 16 U.S.C. § 1201 *et seq.*

Northern Pacific Halibut Act, 16 U.S.C. § 772 *et seq.*

Pacific Salmon Treaty Act of 1985, 16 U.S.C. §§ 3631 *et seq.*

Renewable Energy Industry Development Act of 1983, 42 U.S.C. § 6276.

Tuna Convention Act, 16 U.S.C. § 951 *et seq.*

Weather Modification Reporting Act of 1972, 15 U.S.C. §§ 330 *et seq.*

Whaling Convention Act, 16 U.S.C. § 981 *et seq.*

Yellowstone National Park Act, 16 U.S.C. §§ 21 through 460mm.

APPENDIX E

U.S. AND INTERNATIONAL UNITS OF WEIGHT AND MEASURE

U.S. to International - Conversion Factors

To convert from	Mulitply by
Feet to meters	.3
Cubic feet to cubic meters	.028317
Acres to hectares	.4
Miles to kilometers	1.6
Square miles to square kilometers	2.6
Gallons to liters	3.8
Gallons to cubic meters	.003785
Gallons to barrels	42
Barrels to cubic meters	.159
Pounds to kilograms	.45
Pounds to metric tons	.000454
Board feet to cubic meters	.0045

To convert miles per gallon to liters per 100 kilometers: Divide 235.24 by number of miles per gallon.

International to U.S. - Conversion Factors

To convert from	Multiply by
Meters to feet	3.3
Cubic meters to cubic feet	35.31467
Hectares to acres	2.47
Kilometers to miles	.62
Square kilometers to square miles	.4
Liters to gallons	.26
Cubic meters to gallons	264.172
Cubic meters to barrels	6.29
Kilograms to pounds	2.2
Metric tons to pounds	2,204.623

Numbering

Throughout the report, "billions" has been expressed as "thousand-millions" and "trillions" as "million-millions."

APPENDIX F

PREPARATION OF THE UNITED STATES NATIONAL REPORT

The United States National Report was compiled in preparation for the United Nations Conference on Environment and Development (UNCED), to be held in Rio de Janeiro, Brazil, on June 1-12, 1992. The U.S. National Report reviews the nation's experience over the 20 years since the 1972 United Nations Conference on the Human Environment in Stockholm, Sweden. Along with reports from other countries participating in the conference, it will be used by the UNCED secretariat to analyze global and regional trends and practices, as well as localized problems, which are shared by many countries. The report also will be used to share information on environment and development issues with other countries and within the United States.

The U.S. National Report is based on the guidelines for national reports that were adopted at the first session of the UNCED Preparatory Committee. The sections address the topics outlined in United Nations General Assembly Resolution 44/228, which sets out the scope and the terms of reference for UNCED. To prepare the report, the President's Council on Environmental Quality first convened a federal interagency team (see Acknowledgements) in December 1990. Each section of the report was assigned to a federal agency which assumed the lead role in drafting that section. Other agencies contributed information, drafted subsections of text, and participated in the review and revision process.

At the end of May 1991, a draft report was made available for public comment for a period of approximately six weeks. During the public comment period, the draft report was discussed at a series of five "roundtables," or public meetings where experts discussed specific report topics. Roundtable participants (see Acknowledgements) were nominated by various nongovernmental organizations. Senior federal officials selected participants and ensured that environmental and development organizations, women, minorities, indigenous peoples, youth, academia, labor, and business and industry groups were represented. Participants were invited to comment on the draft report and to use the information contained in the report as a basis for identifying priority issues that the United States might discuss in the future. Two public hearings were planned by non-governmental organizations in conjunction with the roundtables: one in Baltimore, Maryland, following the Baltimore Roundtable and one in St. Louis, Missouri following the Chicago, Illinois Roundtable. In addition, a number of non-governmental organizations have been convening meetings since the roundtables to consider issues that should be raised at UNCED.

After the public comment period, the federal interagency team revised the report, considering written comments, roundtable discussions and discussions at other public meetings. The report was circulated in late November and early December 1991 for final policy clearance by senior officials at all of the federal agencies and departments involved in environment and development policies and programs.

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The U.S. National Report roundtables were sponsored by the Council on Environmental Quality with assistance from many organizations and individuals:

ROUNDTABLE I: Warrenton, Virginia, May 18, 1991

Co-sponsored by the American Bar Association Standing Committee on Environmental Law: Annual Conference Plenary Discussion Facilitated by Dinah Bear, Council on Environmental Quality and Annie Petsonk, Department of Justice.

ROUNDTABLE II: San Francisco, California, June 3-4, 1991

Co-Chairs:

David Cottingham, National Oceanic and Atmospheric Administration
Tom Lovejoy, Smithsonian Institution
LaJuana Wilcher, Environmental Protection Agency

Vice-Chairs:

Anthony Cortese, Tufts University
Elliott Norse, Center for Marine Conservation

Participants:

David Brower, Earth Island Institute
Bill Brown, Waste Management Inc.
Suzanne Butterfield, California Department of Water Resources
Judith Connor, The Nature Conservancy
Christina Desser, Muir Investment Trust
Peter Douglas, California Coastal Commission
Bill Frank, Jr., Northwest Indian Fisheries Commission
Richard Gutting, National Fisheries Institute
Charles Higginson, Council on Ocean Law
John Humke, The Nature Conservancy
Dwayne Lee, Port of Los Angeles
Marda Mayo, U.S. Citizens Network for UNCED
Kathy McGlauflin, Project Learning Tree
John Monarch, Chevron
Debra Moore, Environmental Defense Fund
Andy Palmer, American Oceans Campaign
George Paul, Lewis & Roca
Michelle Perrault, Sierra Club
Claude Poncelet, Pacific Gas & Electric
Kathryn Cameron Porter, Conservation International
Mike Smith, American Museum of Natural History
Merv Tanno, Council of Energy Resource Tribes
Sherri Tonn, Pacific Lutheran University

Special Assistance:

Maria Brown, Center for Marine Conservation
Katie Genshlea, U.S. Citizens Network for UNCED
Terry MacGillivray, TRI

ROUNDTABLE III: Boulder, Colorado, June 13-14, 1991

Co-Chairs:

Richard Roldan, Department of the Interior
Mike Shapiro, Environmental Protection Agency
Richie Williamson, Department of Energy

Vice-Chairs:

Ralph Cavanagh, Natural Resources Defense Council
Thomas Malone, St. Joseph College

Participants:

Sarah Bates, University of Colorado
Scott Berg, American Forest Council
Robert "Hap" Boyd, Kenetech Corporation
Daniel Chiras, Colorado Environmental Coalition
Martha Hahn, Grand Canyon Trust
Robert Haywood, Pacific Gas & Electric
Don Kratz, American Mining Congress
Doug Larson, Western Interstate Energy Board
David Lester, Council of Energy Resource Tribes
Dan Magraw, University of Colorado
James Mahoney, International Technology Corp.
Mike McCloskey, Sierra Club
Jana McKeag, National Indian Gaming Commission
Steve Moore, Native American Rights Fund
Gale A. Norton, Attorney General, Colorado
Gareth Porter, Environmental & Energy Studies Institute
Stephen Schneider, National Center for Atmospheric Research
Dewey Schwalenberg, Native American Fish & Wildlife Society
Larry Sherwood, American Solar Energy Society
Craig Vogel, National Coal Association
Tom Walton, General Motors Corporation
Bob Woodall, Georgia Power Company

Special Assistance:

Bruce Byers, International Peace Research Institute
Lisa Grayson, JT&A
John Wade, Sierra Club

ROUNDTABLE IV: Chicago, Illinois, June 26-27, 1991

Co-Chairs:

Nancy Carter, Department of State
Sidney Jones, Department of the Treasury
Deborah Wince-Smith, Department of Commerce

Vice-Chairs:

Robert Masuda, YMCA of the USA
Thomas Spaulding, YMCA of the USA
W. Ross Stevens, III, E.I. DuPont de Nemours and Co.

Participants:

Nancy Alexander, Friends Committee on National Legislation
Lakshmi Bharadwaj, University of Wisconsin
Phil Claxton, World Population Society
Jason Clay, Cultural Survival, Inc.
Karen Conner, Institute for Social Ecology
Dale Didion, Carrying Capacity Network
Richard Godown, Industrial Biotechnology Association
Ambassador Joseph Greenwald, U.S. Council on Industry and Business
John Hall, Sustainable Agriculture Working Group
Ann James, Office of Congressman John Porter (Illinois)
Kathy Kushner, Hudson Institute
Tom Merrick, Population Reference Bureau
Nader Nazmi, Lake Forest College
Kathyrn Cameron Porter, Conservation International
Niel Ritchie, Institute for Agriculture and Trade Policy
Michael Teitelbaum, Alfred P. Sloan Foundation
Shyam Thapa, Family Health International
George Tolley, University of Chicago
Will Toor, Student Environmental Action Coalition
F.A. Vogelsberg Jr., E.I. DuPont de Nemours and Co.

Special Assistance:

Lisa Grayson, JT&A

ROUNDTABLE V: Baltimore, Maryland, July 11-12, 1991

Co-Chairs:

Scott Daniels, Department of Health & Human Services
Linda Fisher, Environmental Protection Agency
Michael McGinnis, Department of Health & Human Services
Larry Reiter, Environmental Protection Agency
Frank Young, Department of Health & Human Services

Vice-Chairs:

J. Ron Condray, Monsanto Chemical Company
Robert Pollard, Institute for Global Communications

Participants:

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Don Edwards, Panos Institute
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Louis Head, Southwest Organizing Project
Burr Henemann, Center for Living Resources
Rekha Mehra, International Center for Research on Women
Robert Percival, University of Maryland at Baltimore
Jerry Pogee, Green Seal
Michael Powell, Office of the Attorney-General, Maryland
Linda Schierow, Congressional Research Service
Fran Spivy-Weber, National Audubon Society
Terry Yosie, American Petroleum Institute

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Marilyn Karr, Baltimore Citizens Committee
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